UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 13, 2010

Mary A. Colligan
Assistant Regional Administrator for
Protect Resources
National Marine Fisheries Service
Northeast Regional Office
55 Great Republic Drive
Gloucester, MA 01930-2276

SUBJECT: BIOLOGICAL ASSESSMENT FOR LICENSE RENEWAL OF THE HOPE CREEK GENERATING STATION AND SALEM NUCLEAR GENERATING STATION UNITS 1 AND 2

Dear Ms. Colligan:

The Nuclear Regulatory Commission (NRC) has prepared the enclosed biological assessment (BA) (Enclosure 1) to evaluate whether the proposed renewal of the Hope Creek Generating Station (HCGS) and Salem Nuclear Generating Station Units 1 and 2 (Salem) operating licenses for a period of an additional 20 years would have adverse effects on listed species. The proposed action (license renewal) is not a major construction activity.

In a letter dated December 23, 2009, the NRC requested that the National Marine Fisheries Service (NMFS) provide information on Federally listed endangered or threatened species, as well as proposed, or candidate species, and any designated critical habitat that may be in the vicinity of HCGS and Salem sites and their transmissions line corridors. The NMFS replied to this request on February 11, 2010, and identified five federally listed species and one candidate species under NMFS jurisdiction that could occur in the Delaware Estuary in the vicinity of HCGS and Salem sites. These species included the endangered shortnose sturgeon (*Acipenser brevirostrum*), the candidate Atlantic sturgeon (*A. oxyrinchus oxyrinchus)*, and four sea turtles: the threatened loggerhead (*Carretta carretta*), the endangered Kemp's ridley (*Lepidochelys kempii*), the green (*Chelonia mydas*), and the leatherback (*Dermochelys coriacea*).

This BA provides an evaluation of the potential impact of renewing the HGCS and Salem operating licenses for an additional 20 years of operation on five Federally listed threatened species and one candidate species with the potential to occur in the Delaware Estuary in the vicinity of HCGS and Salem sites.

The NRC staff has determined that license renewal for HCGS will have no effect on any listed species. For Salem, the NRC staff has determined that license renewal may affect but not likely to adversely affect the endangered snortnose sturgeon, the threathened loggerhead and green turtles and the endangered Kemp's ridley and the candidate Atlantic sturgeon. The NRC staff determined that license renewal for Salem will have no effect on the leatherback turtles in the Delaware Estuary.

We are requesting your concurrence with our determination. In reaching our conclusion, the NRC staff relied on information provided by the applicant, on research performed by NRC staff, and on information from NMFS (including current listings of species provided by the NMFS). If you have any questions regarding this BA or the staff's request, please contact Ms. Leslie Perkins, Environmental Project Manager, at 301-415-2375 or by e-mail at leslie.perkins@nrc.gov.

Sincerely,

Bo M. Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-272, 50-311, and 50-354

Enclosure:
As stated

cc w/encl: Distribution via Listserv

Biological Assessment

Salem Nuclear Generating Station Units 1 and 2
Hope Creek Generating Station Unit 1
License Renewal

DECEMBER 2010

Docket Numbers 50-272, 50-311, and 50-354

U.S. Nuclear Regulatory Commission
Rockville, Maryland

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Abbreviations and Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
ac	acre
cm	centimeter
DPS	distinct population segment
DRBC	Delaware River Basin Commission
ESA	Endangered Species Act of 1973
fps	feet per second
ft	foot
FWS	U.S. Fish and Wildlife Service
g	gram
gal	gallon
gal/yr	gallons per year
ha	hectare
HCGS	Hope Creek Generating Station
hrs	hours
in.	inch
kg	kilogram
lb	pound
m	meter
m/s	meters per second
m^3	cubic meters
m^3/day	cubic meters per day
m^3/yr	cubic meters per year
MBTU/hr	million British thermal units per hour
mg/L	milligrams per liter
mgd	million gallons per day
mi	mile
MSL	mean sea level
mt/yr	metric tons per year
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service
NRC	U.S. Nuclear Regulatory Commission
oz	ounce
ppt	parts per thousand
PSEG	PSEG Nuclear, LLC
ROW	right-of-way
Salem	Salem Nuclear Generating Station, Units 1 and 2
SEIS	Supplemental Environmental Impact Statement

Biological Assessment of the Potential Effects on Federally Listed Endangered or Threatened Species from the Proposed License Renewal for the Salem Nuclear Generating Station and Hope Creek Generating Station

1.0 Introduction

The U.S. Nuclear Regulatory Commission (NRC) prepared this Biological Assessment to support the draft supplemental environmental impact statement (SEIS) for renewal of the operating licenses for Salem Nuclear Generating Station Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS), the notice of availability of which was published in the Federal Register on October 28, 2010 (75 FR 66398). Salem and HCGS are located in New Jersey on the eastern shore of the Delaware Estuary. The current 40-year licenses expire on August 13, 2016, for Salem, Unit 1; April 18, 2020, for Salem, Unit 2; and April 11, 2026, for HCGS. The proposed license renewals for which this Biological Assessment has been prepared would permit the facilities to operate for an additional 20 years.

PSEG Nuclear, LLC (PSEG), which operates Salem and HCGS, prepared Environmental Reports (PSEG, 2009a; PSEG, 2009b) as part of its applications for renewal of the Salem and HCGS licenses. In the Environmental Reports, PSEG analyzed the environmental impacts associated with the proposed license renewals, considered alternatives to the proposed actions, and reviewed mitigation measures for reducing adverse environmental effects. NRC is using the Environmental Reports, information published by other Federal agencies, and available scientific literature as the basis for this Biological Assessment and the SEIS (NRC, 2010), which is a facility-specific supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437 (NRC, 1996).

Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA), as amended, NRC staff requested via letter dated December 23, 2009 (NRC, 2009a), that the U.S. Fish and Wildlife Service (FWS) provide information on Federally listed endangered or threatened species, as well as proposed or candidate species, and any designated critical habitats that may occur in the vicinity of Salem and HCGS. In their response to NRC, the FWS (2010) indicated that no Federally listed species under the FWS's jurisdiction are known to occur in the vicinity of Salem and HCGS. The FWS (2010) noted that areas of potential habitat and/or known occurrences of the bog turtle (*Clemmys muhlenbergii*) and swamp pink (*Helonias bullata*) exist along two transmission line rights-of-way (ROWs) associated with Salem and HCGS, but that continued operation of Salem and HCGS are unlikely to adversely affect either species because PSEG had previously committed to adopting FWS-recommended conservation measures along the transmission line ROWs.

Concerning species under the jurisdiction of the National Marine Fisheries Service (NMFS), consultation pursuant to Section 7 of the ESA regarding Salem and HCGS has been ongoing between the NRC and NMFS since 1979, and NMFS most recently issued a Biological Opinion for the two facilities on May 14, 1993 (NMFS, 1993), which was then amended by letter dated January 21, 1999 (NMFS, 1999). The 1993 Biological Opinion's Incidental Take Statement pertained to the loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and shortnose sturgeon (*Acipenser brevirostrum*). Because the proposed license renewal of Salem and HCGS would be a Federal action that requires consultation under Section 7, NRC contacted NMFS on December 23, 2009 (NRC, 2009b), to request updated information on Federally listed endangered or threatened species, as well as proposed or candidate species, and any designated critical habitats that may occur in the vicinity of Salem and HCGS. In the NMFS's response to NRC's request, the NMFS (2010) identified the four Federally listed species mentioned above, as well as the leatherback turtle (*Dermochelys coriacea*) and one candidate species—the Atlantic sturgeon (*A. oxyrinchus oxyrinchus*)—that occur in the Delaware Estuary and may be present within the vicinity of Salem and HCGS. The NMFS (2010) noted that the NMFS would be required to issue a new Biological Opinion and associated Incidental Take Statement if the NRC and NMFS determine through consultation that the proposed action is likely to adversely affect any listed species.

Accordingly, this Biological Assessment focuses on evaluating the potential effects from continued operation of Salem and HCGS on the Federally listed species under NMFS's jurisdiction that occur in the Delaware Estuary.

2.0 Description of Proposed Action

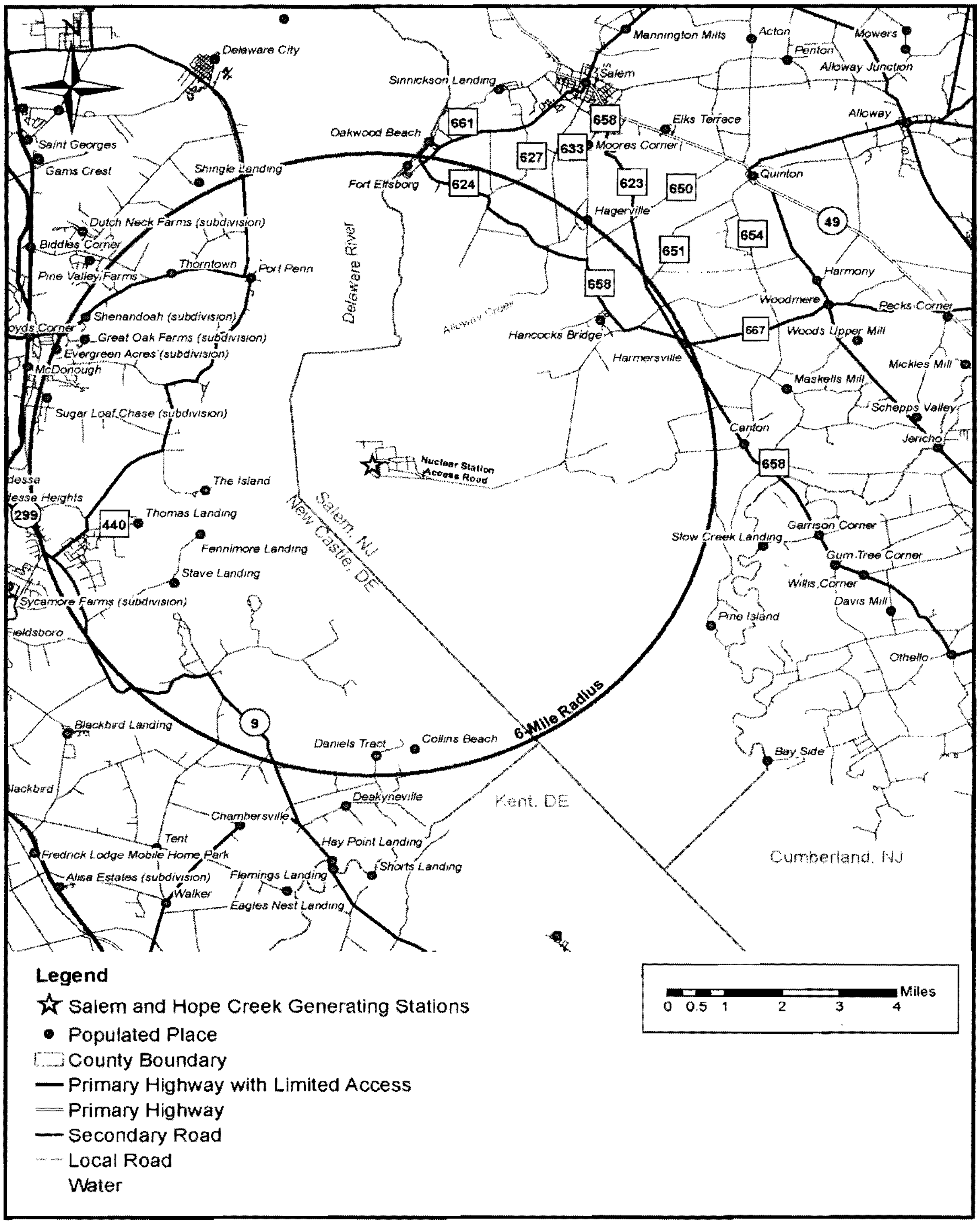
The proposed Federal action is NRC's decision of whether or not to renew each of the operating licenses for Salem and HCGS for an additional 20 years beyond the original 40-year term of operation. PSEG initiated the proposed Federal action by submitting applications for license renewal of Salem, for which the existing licenses, DPR-70 (Unit 1) and DPR-75 (Unit 2), expire August 13, 2016, and April 18, 2020, respectively; and HCGS, for which the existing license, NPF-57, expires April 11, 2026. If NRC issues renewed licenses for Salem and HCGS, PSEG could continue to operate until the 20-year terms of the renewed licenses expire in 2036 and 2040 for Salem, Unit 1 and Unit 2, respectively, and 2046 for HCGS. If the operating licenses are not renewed, then the facilities must be shut down on or before the expiration date of the current operating licenses: August 13, 2016, and April 18, 2020, for Salem, Unit 1 and Unit 2, respectively; and April 11, 2026, for HCGS.

No major construction, refurbishment, or replacement activities are associated with the license renewals. During the proposed license renewal term, PSEG would continue to perform site maintenance activities as well as vegetation management on the transmission line ROWs that connect Salem and HCGS to the electric grid.

2.1 Site Location and Description

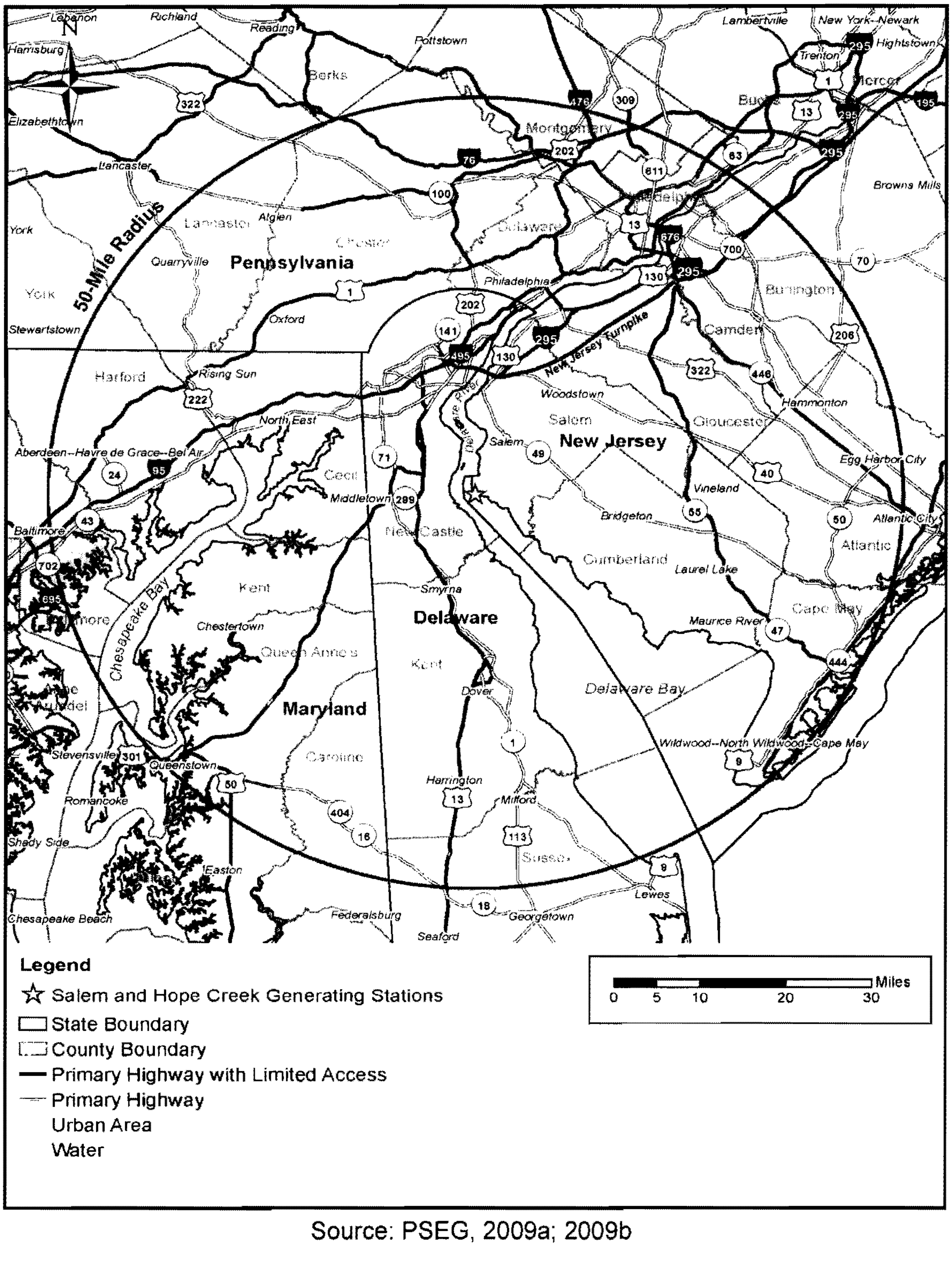
Salem and HCGS lie at the southern end of Artificial Island located on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey, at which point the river is approximately 2.5 miles (mi; 4 kilometers [km]) wide. Artificial Island is a man-made island approximately 1,500 ac (600 ha) in size that consists of tidal marsh and grassland. The U.S. Army Corps of Engineers (USACE) created the island in the twentieth century by the deposition of hydraulic dredge spoil material atop a natural sand bar that projected into the river. The average elevation of the island is about 9 feet (ft; 3 meters [m]) above mean sea level (MSL) with a maximum elevation of approximately 18 ft (5.5 m) above MSL (AEC, 1973). The site is located approximately 17 mi (27 km) south of the Delaware Memorial Bridge, 35 mi (56 km) southwest of Philadelphia, Pennsylvania, and 8 mi (13 km) southwest of the City of Salem, New Jersey. Figures 1 and 2, respectively, show the location of the Salem and HCGS facilities and the areas within a 6-mi (10-km) radius and 50-mi (80-km) radius of the facility.

Figure 1. Location of the Salem and HCGS Sites Within a 6-Mile Radius



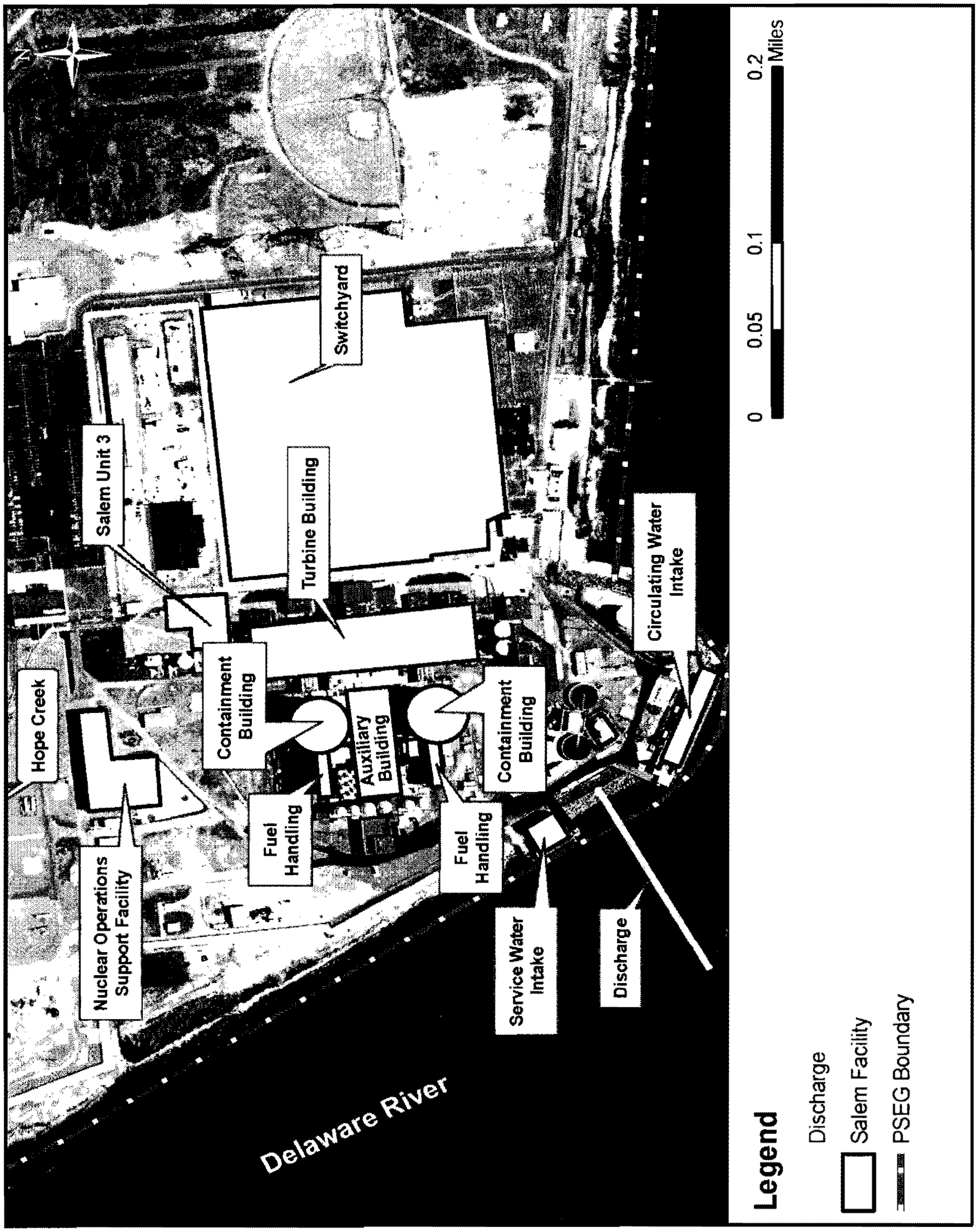
Source: PSEG, 2009a; 2009b

Figure 2. Location of the Salem and HCGS Sites Within a 50-Mile Radius



Source: PSEG, 2009a; 2009b

Figure 3. Salem Site and Facility Layout



Source: PSEG, 2009a

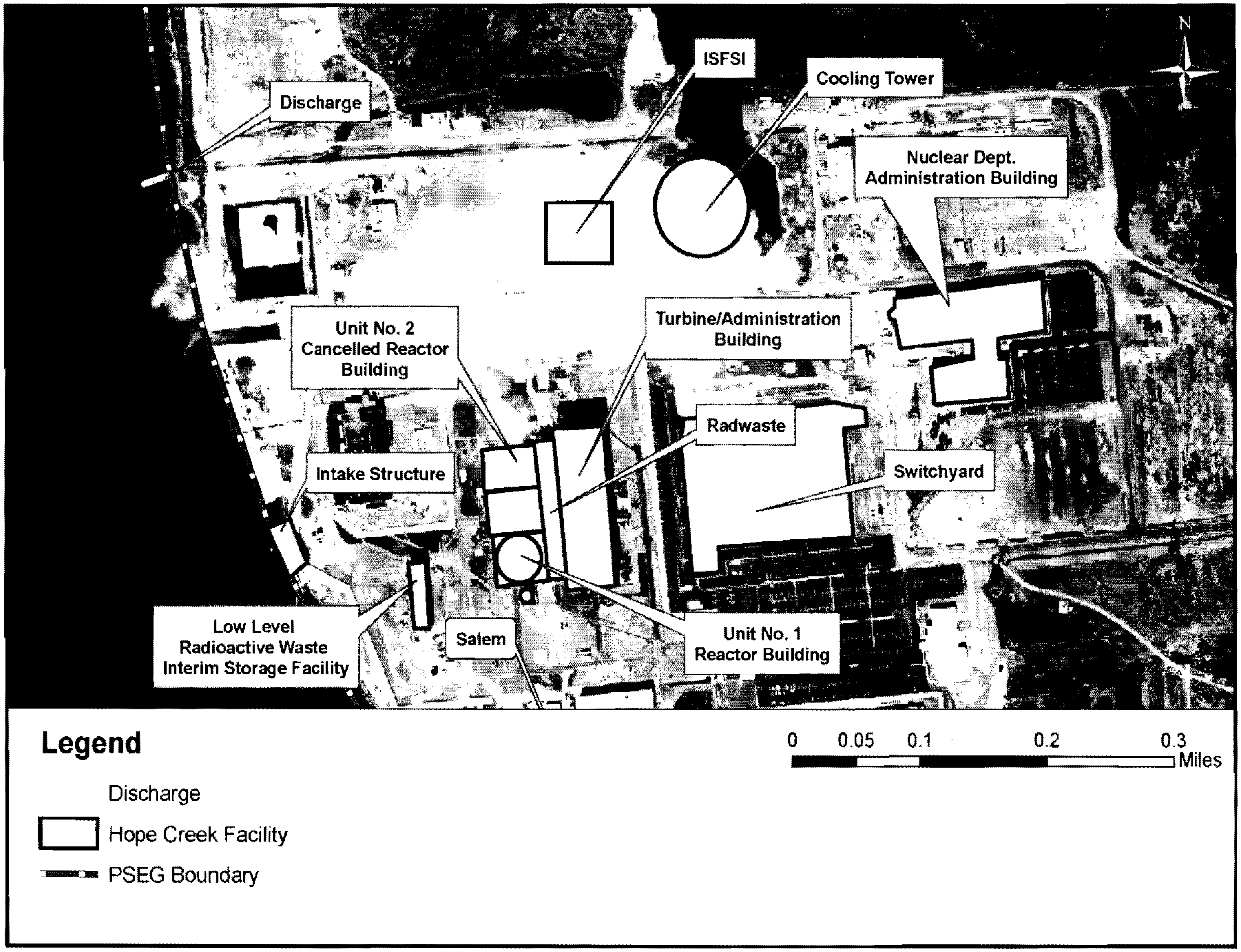


Figure 4. HCGS Site and Facility Layout

Source: PSEG, 2009b

PSEG owns approximately 740 ac (300 ha) at the southern end of the Artificial Island, of which Salem occupies approximately 220 ac (89 ha) and HCGS occupies about 153 ac (62 ha). The remainder of Artificial Island, north of the PSEG property, is owned by the U.S. Government and the State of New Jersey; this portion of the island remains undeveloped. The land adjacent to the eastern boundary of Artificial Island consists of tidal marshlands of the former natural shoreline. The northernmost tip of Artificial Island (owned by the U. S. Government) is within the State of Delaware boundary (PSEG, 2009a; 2009b). Figures 3 and 4 are aerial photographs of the Salem and HCGS sites, respectively.

The region within 15 mi (24 km) of the site is primarily utilized for agriculture. The area also includes numerous parks, wildlife refuges, and preserves such as Mad Horse Creek Fish and Wildlife Management Area to the east; Cedar Swamp State Wildlife Management Area to the south in Delaware; Appoquinimink, Silver Run, and Augustine State Wildlife Management areas to the west in Delaware; and Supawna Meadows National Wildlife Refuge to the north. The Delaware Bay and estuary is recognized as containing wetlands of international importance and an international shorebird reserve (NJSA, 2008). The nearest permanent residences are located 3.4 mi (5.5 km) south-southwest and west-northwest of Salem and HCGS across the river in Delaware. The nearest permanent residence in New Jersey is located 3.6 mi (5.8 km) east northeast of the facilities (PSEG, 2009d). The closest densely populated center (with 25,000 residents or more) is Wilmington, Delaware, located 15 mi (24 km) north of Salem and HCGS. No heavy industry exists in the area surrounding Salem and HCGS; the nearest such industrial area is located approximately 10 mi (16 km) northwest of the site near Delaware City, Delaware (PSEG, 2009e).

2.2 Cooling Water System Description and Operation

The Delaware Estuary provides condenser cooling water and service water for both Salem and HCGS. However, the Salem and HCGS facilities use different types of cooling water systems.

Salem is a two-unit station with pressurized water. Each of the two units has a once-through cooling water system that withdraws brackish water from the Delaware Estuary through an intake structure located at the shoreline on the southern end of the site. Salem also withdraws water from the estuary for its service water system. (PSEG, 2009a)

HCGS is a one-unit station with a boiling water reactor. HCGS has a closed-cycle cooling water system for that includes intake and discharge structures in the Delaware Estuary and a natural draft cooling tower. HCGS also withdraws water from the estuary for its service water system. (PSEG, 2009b)

Each facility's system is described in more detail in the following sections.

2.2.1 Salem Circulating and Service Water Systems

Salem has two intake systems: the circulating water system, which provides cooling water for main condenser cooling, and the service water system, which provides water for the reactor safeguard and auxiliary systems.

Circulating Water System Intake

The circulating water system withdraws brackish water from the Delaware Estuary via 12 cooling water pumps that connect to a 12-bay intake structure located on the shoreline at the south end of the site.

Before water is processed through the circulating water system, it must pass through several features that prevent intake of debris and biota into the cooling water pumps (PSEG, 2006b):

- Removable Ice Barriers. During the winter, removable ice barriers are installed in front of the intakes to prevent damage to the intake pumps from ice formed on the Delaware Estuary. These barriers consist of pressure-treated wood bars and underlying structural steel braces. The barriers are removed early in the spring and replaced in late fall.

- Trash Racks. After intake water passes through the ice barriers (when installed), it flows through fixed course-grid trash racks. These racks prevent large organisms and debris from entering the pumps. The racks are made from 0.5 inch (in.; 1.3 centimeters [cm]) steel bars placed on 3.5-in. (8.9-cm) centers, which create a 3-in. (7.6-cm) clearance between each bar. The racks are inspected regularly by PSEG employees, who remove any debris caught on them with mechanical, clamshell-type trash rakes. The trash rakes include a hopper that stores and transports removed debris to a pit at the end of each intake, where it is dewatered by gravity and disposed of off-site.

- Traveling Screens. After intake water passes through the trash racks, it then travels through finer vertical travelling screens. These are modified Ristroph screens designed to remove debris and biota small enough to have passed through the trash racks while minimizing death or injury. The travelling screens are made of wire mesh with 0.25 in. x 0.5 in. (0.64 cm x 1.3 cm) openings. Water moves through these screens at approximately 0.9 foot per second (fps; 0.3 meters per second [m/s]) at mean low tide.

- Fish Return System. 10-ft (3-m) fish buckets are attached across the bottom of each traveling screen panel. As the travelling screens reach the top of each rotation, fish and other organisms slide along horizontal catch screens and are caught in the fish buckets. As the travelling screens continue to rotate, the buckets invert, a low pressure water spray washes fish off the screen, and the fish slide through a flap into a two-way fish trough. Remaining debris is then washed off the screen by a high-pressure water spray and disposed of in a separate debris trough. The contents of both the fish troughs and the debris troughs return to the estuary. The release of fish and debris is timed so that tidal flow will carry them away from the intake, reducing the likelihood of re-impingement. Thus, the troughs empty on either the north or south side of the intake structure depending on the direction of tidal flow.

Service Water System Intake

The service water system intake is located approximately 400 ft (122 m) north of the cooling water system intake within the Delaware Estuary. The service water system intake has 4 bays, each containing 3 pumps, for a total of 12 service water pumps. The average velocity throughout the service water system intake is less than 1 fps (0.3 m/s). The service water system intake structure is equipped with trash racks, traveling screens, and a fish return system to prevent the intake of debris and biota similar to those described for the circulating water system (PSEG, 1999b):

- Trash Racks. Before entering the intake bays, service water travels through mechanical trash racks composed of 0.5-in. (1.3-cm)-wide steel bars with slot openings of 3 in. (7.6 cm). The trash racks remove large debris and organisms, which are disposed of off-site.

- Traveling Screens and Fish Return System. After intake water passes through the trash racks, it then travels under a curtain wall and then through conventional vertical traveling screens to remove debris and biota small enough to have passed through the trash racks while minimizing death or injury. The travelling screens are made of wire mesh with 3/8-in.^{2} (0.95-cm^2) openings. Water moves through these screens at less than 1 fps (0.3 m/s) at mean low tide. The screens are washed with a low-pressure spray, and debris and organisms are deposited into troughs and routed back to the Delaware Estuary.

Water Discharge

Both the Salem circulating water and service water systems discharge heated water back to the Delaware Estuary through a single discharge piping system. This piping system consists of six adjacent pipes that are 7 ft (2 m) in diameter and spaced 15 ft (4.6 m) apart. As water travels through these pipes towards the estuary, the 12 pipes merge into 3 larger pipes that are 10 ft (3 m) in diameter (PSEG, 2006b). The discharge piping is buried the majority of its 500-ft (150-m) length. Water is discharged into the estuary and perpendicular to the prevailing currents at a depth of about 31 ft (9.5 m) at mean tide (PSEG, 1999b). At full power, Salem is designed to discharge approximately 3,200 million gallons per day (mgd; 12 million cubic meters per day [m^3/day]) at a velocity of about 10 fps (3 m/s) (PSEG, 1999b). Water at the discharge point is 0 to 15 °F (0 to 8.3 °C) warmer than the estuary water to which it is being discharged (PSEG, 1999b). The average temperature increase at the discharge is from 8 to 10 °F (4 to 6 °C) (PSEG, 1999b).

2.2.2 HCGS Circulating and Service Water Systems

HCGS withdraws water through only one intake structure. Once withdrawn from the estuary, water first runs through the service water system, and is then sent to the circulating water system for use as cooling tower make-up water. As with Salem, the HCGS circulating water system provides water for main condenser cooling, while the service water system provides water for reactor safeguard and auxiliary systems.

Service Water System Intake

Water is withdrawn from the Delaware Estuary via an eight-bay intake that is situated parallel to the shoreline. Only four of the eight bays are operational; the remaining four were constructed for a second HCGS reactor, which was never built. At the intake, water flows into the intake structure at a maximum velocity of 0.35 fps (0.11 m/s). As with Salem's intakes, the HCGS intake includes several features to prevent intake of debris and biota before water enters the cooling water pumps (PSEG, 2009b):

- Trash Racks. Before water enters the intake, trash racks prevent large organisms and debris from entering the intake by regularly sweeping the face of the intake structure. Mechanical rakes remove any collected debris and deposit it for off-site disposal. Water travels through the trash racks at about 0.1 fps (0.03 m/s).

- Skimmer Wall: A skimmer wall is located behind the trash racks to prevent the intake of oil slicks or ice. Water travels under the skimmer wall and into one of the four active bays at a maximum speed of 0.35 fps (0.11 m/s).
- Traveling Screens. After entering one of the four active bays, water passes through traveling screens with 1/2 in. x 1/8 in. (1.3 cm x 0.32 cm) openings in order to remove debris and biota small enough to have passed through the trash racks and skimmer wall while minimizing death or injury (NRC, 2007). Traveling screens are rotated regularly, but not continuously.
- Fish Return System. Buckets, located on the lower lip of the traveling screens, catch fish and other organisms. As the travelling screens reach the top of each rotation, fish and other organisms are caught in the fish buckets. As the travelling screens continue to rotate, the buckets invert, a low pressure water spray washes fish off the screen and into return troughs. Remaining debris is then washed off the screen by a high-pressure water spray. Fish and debris return to the Delaware Estuary in combined troughs south of the intake structure.

After passing through the trash racks, skimmer wall, and traveling screens, water enters the service water pumps and is processed through the service water system. To prevent organic buildup and biofouling in the heat exchangers and piping of the service water system, sodium hypochlorite is continuously injected at the suction of the service water pumps.

Circulating Water System and Water Discharge

HCGS's circulating water system consists of one 512-ft (156-m) high, single counterflow, hyperbolic, natural draft cooling tower with make-up, blowdown, and basin bypass systems; four circulating water pumps; a two-pass condenser; and a closed-loop circulating water piping arrangement. Once water is processed through the service water system, it is sent to the circulating water system to cool the main condenser and for use as cooling tower make-up water; therefore, debris and biota have already been removed from the water before it enters the circulating water system. Sodium hydroxide and sodium hypochlorite are added to the circulating water system to minimize scaling and prevent biofouling in the cooling tower. Cooling tower blowdown is de-chlorinated with ammonium bisulfate before being discharged to the Delaware Estuary. (PSEG, 2009b)

The HCGS circulating water system loses water through evaporative loss from the cooling tower and blowdown removed from the system to control the buildup of suspended solids. Heated water from cooling tower blowdown is discharged to the estuary through an underwater conduit located 1,500 ft (460 m) upstream of the HCGS intake. The HCGS discharge pipe extends 10 ft (3.0 m) offshore and is situated at mean tide level. (PSEG, 2009b)

2.3 Surface Water Use and Facility NJPDES Permits' Limitations

The Delaware River Basin Commission (DRBC) and the State of New Jersey regulate surface water use for Salem and HCGS. The DRBC authorizes Salem to withdraw surface water from the Delaware Estuary under a contract that was originally signed in 1977 (DRBC, 1977) and was approved for a 25-year term in 2001 (DRBC, 2001). The DRBC authorizes HCGS to withdraw surface water from the Delaware Estuary under a contract that was originally signed in 1975 that was then revised in 1985 following PSEG's decision to build only one unit (DRBC, 1984a). The State of New Jersey regulates water use and effluent discharges under the New Jersey Pollutant Discharge Elimination System (NJPDES) Permit Nos. NJ005622 (for Salem) and NJ0025411 (for HCGS).

Salem

Salem's NJPDES permit limits the total withdrawal of Delaware River water to 3,024 mgd (11.4 million m^3/d), with a monthly maximum of 90,720 million gallons (gal.; 343 million cubic meters [m^3]) (NJDEP, 2001). DRBC's contract with Salem authorizes the facility to withdraw water not to exceed 97,000 million gal. (367 million m^3) in a single 30-day period (DRBC, 1977; DRBC, 2001). PSEG reports withdrawal volumes to the New Jersey Department of Environmental Protection (NJDEP) through monthly Discharge Monitoring Reports.

From June 1 through September 30, Salem may discharge water at a maximum temperature of 115 °F (46.1 °C) (PSEG, 1999b). Year-round, Salem's NJPDES permit limits the change in temperature such that discharged water may not exceed a 27.5 °F (15.3 °C) change in temperature from the ambient estuary water temperature (PSEG, 1999b).

Table 1 summarizes specific discharge locations, their associated reporting requirements, and discharge limits under Salem's NJPDES.

Table 1. NJPDES Permit Requirements for Salem Nuclear Generating Station

Discharge	Description	Required Reporting	Permit Limits
DSN 048C	Input is NRLWDS and Outfall DSN 487B Discharges to outfall DSNs 481A, 482A, 484A, and 485A	Effluent flow volume	None
		Total suspended solids	50 mg/L monthly average
			100 mg/L daily maximum
		Ammonia (Total as N)	35 mg/L monthly average
			70 mg/L daily maximum
		Petroleum hydrocarbons	10 mg/L monthly average
			15 mg/L daily maximum
		Total organic carbon	Report monthly average
			50 mg/L daily maximum
DSNs 481A, 482A, 483A, 484A, 485A, and 486A (the same requirements for each)	Input is cooling water, service water, and DSN 048C Outfall is six separate discharge pipes	Effluent flow volume	None
		Effluent pH	6.0 daily minimum
			9.0 daily maximum
		Intake pH	None
		Chlorine-produced oxidants	0.3 mg/L monthly average
			0.2 and 0.5 mg/L daily maximum
		Temperature	None
DSN 487B	#3 skim tank, and storm water from north portion	Effluent flow	None
		pH	6.0 daily minimum

Discharge	Description	Required Reporting	Permit Limits
			9.0 daily maximum
		Total suspended solids	100 mg/L daily maximum
		Temperature	43.3°C daily maximum
		Petroleum hydrocarbons	15 mg/L daily maximum
		Total organic carbon	50 mg/L daily maximum
DSN 489A	Oil/water separator, turbine sumps, and storm water from south portion	Effluent flow	None
		pH	6.0 daily minimum
			9.0 daily maximum
		Total suspended solids	30 mg/L monthly average
			100 mg/L daily maximum
		Petroleum hydrocarbons	10 mg/L monthly average
			15 mg/L daily maximum
		Total organic carbon	50 mg/L daily maximum
DSN Outfall FACA	Combined for discharges 481A, 482A, and 483A	Net temperature (year round)	15.3°C daily maximum
		Gross temperature	46.1°C daily maximum
		(June to September)	
		Gross temperature	43.3°C daily maximum
		(October to May)	
DSN Outfall FACB	Combined for discharges 484A, 485A, and 486A	Net temperature (year round)	15.3°C daily maximum
		Gross temperature	46.1°C daily maximum
		(June to September)	
		Gross temperature	43.3°C daily maximum
		(October to May)	

MBTU/hr = million British thermal units per hour
mg/L = milligrams per liter
Source: NJDEP, 2001

HCGS

Though PSEG is required to measure and report withdrawal volumes to the NJDEP, HCGS's NJPDES permit does not specify limits on the total withdrawal volume of Delaware Estuary water (NJDEP, 2003). HCGS's actual withdrawal of water averages to about 66.8 mgd (253 million m^3/day), of which 6.7 mgd (25,400 m^3/day) are returned as screen backwash, and 13 mgd (49,000 m^3/day) are evaporated. The remainder (approximately 46 mgd [174,000 m^3/day]) is discharged back to the estuary (PSEG, 2009b). DRBC's contract with HCGS authorizes the facility to withdraw 16.998 billion gal. per year (gal/yr; 64.3 million cubic meters per year [m^3/yr]), including up to 4.086 billion gal. (17.44 million m^3) of consumptive use (DRBC, 1984a; DRBC, 1984b). To compensate for evaporative losses in the system, the DRBC authorization requires releases from storage reservoirs, or reductions in withdrawal, during periods of low-flow conditions at Trenton, New Jersey (DRBC, 2001). To accomplish this, PSEG is one of several utilities that owns and operates the Merrill Creek Reservoir in Washington, New Jersey, which is used to release water during low-flow conditions as required by the DRBC authorization (PSEG, 2009b).

HCGS's NJPDES permit limits heat dissipation from discharged water to an area no larger than 2500 ft (762 m) upstream or downstream and 1500 ft (457 m) offshore from the discharge point. Outside of the designated area, water temperature changes attributable to the plant cannot exceed the estuary's ambient water temperature by more than 4 °F (2.2 °C) from September through May or by 1.5 °F (0.8 °) in June, July, and August (Najarian Associates, 2004). In addition, the maximum water temperature attributable to the plant outside of the designated area cannot exceed 86 °F (30 °C) (Najarian Associates, 2004).

Table 2 summarizes specific discharge locations, their associated reporting requirements, and discharge limits under HCGS's NJPDES.

Table 2. NJPDES Permit Requirements for HCGS

Discharge	Description	Required Reporting	Permit Limits
DSN 461A	Input is cooling water blowdown and DSN 461C	Effluent flow	None
		Intake flow	None
		Effluent pH	6.0 daily minimum
	Outfall is discharge pipe		9.0 daily maximum
		Chlorine-produced oxidants	0.2 mg/L monthly average
			0.5 mg/L daily maximum
		Effluent gross temperature	36.2oC daily maximum
		Intake temperature	None
		Total organic carbon (effluent gross, effluent net, and intake)	None
		Heat content (June to August)	534 MBTU/hr daily maximum
		Heat content (September to May)	662 MBTU/hr daily maximum
DSN 461C	Input is low volume oily waste from oil/water separator	Effluent flow	None
		Total suspended solids	30 mg/L monthly average
			100 mg/L daily maximum
	Outfall is to DSN 461A	Total recoverable petroleum Hydrocarbons	10 mg/L monthly average
			15 mg/L daily maximum
		Total organic carbon	50 mg/L daily maximum
DSN 462B	Sewage treatment plant effluent, discharges to 461A	Effluent flow	None
		Total suspended solids	30 mg/L monthly average
			45 mg/L weekly average
			83% removal daily minimum
		Biological oxygen demand (BOD)	8 kg/day monthly average
			30 mg/L monthly average
			45 mg/L weekly average

Discharge	Description	Required Reporting	Permit Limits
			87.5 percent removal daily minimum
		Oil and grease	10 mg/L monthly average
			15 mg/L daily maximum
		Fecal coliform	200 /100 ml monthly geometric
			400 /100 ml weekly geometric average
		6 separate metal and inorganic contaminants (cyanide, nickel, zinc, cadmium, chromium, and copper)	None
S16A	Oil/water separator residuals from 461C	24 separate metal and inorganic contaminants	None
		24 separate organic contaminants	None
		Volumes and types of sludge produced and disposed	None
Source: NJDEP, 2005			

2.4 Salem and HCGS Section 7 Consultation History

2.4.1 Section 7 Consultation History Overview

Consultation pursuant to Section 7 of the ESA regarding Salem and HCGS has been ongoing between the NRC and NMFS since 1979. In 1980, NMFS issued a Biological Opinion that concluded that the continued operation of these facilities was not likely to jeopardize the shortnose sturgeon and set a take limit of up to 11 shortnose sturgeon per year. Sea turtles were not included in the 1980 Biological Opinion.

The NRC reinitiated consultation on August 19, 1988, because Salem had impinged a number of sea turtles. The NMFS issued a revised Biological Opinion on January 2, 1991, to include sea turtles. In this Biological Opinion, the NMFS concluded that continued operation of Salem and HCGS would affect sea turtles, but would not jeopardize the continued existence of any populations of threatened or endangered species. The 1991 Biological Opinion also reduced the number of allowable shortnose sturgeon takes based on actual levels of impingement at Salem and HCGS up to that point.

The NMFS modified the 1991 Biological Opinion on August 4, 1992, to increase the total allowable take limit for loggerheads and shortnose sturgeon. However, between June and October 1992, Salem and HCGS exceeded their take limit for Kemp's ridley mortalities and met their take limit for shortnose sturgeon mortalities. The NMFS issued another Biological Opinion on May 14, 1993 (NMFS, 1993), which did not change the take limits of listed species, but which specified that Salem and HCGS should develop a research program using mark/recapture to determine whether Salem has features that attract sea turtles. Also in 1993, PSEG implemented a policy of removing the ice barriers from the trash racks on the intake structure during the period between May 1 and October 24, which resulted in substantially lower turtle impingement rates at Salem.

The NRC reinitiated Section 7 Consultation in 1998 to remove the study requirement from the Salem and HCGS's Incidental Take Statement. The NRC cited the change in PSEG procedure regarding removal of ice barriers during the spring and summer. In response, the NMFS issued a Biological Opinion on January 21, 1999, that removed the study requirement and decreased the number of annual allowable takes of shortnose sturgeon from 10 individuals to 5 individuals based on the review of shortnose sturgeon capture rates at Salem and HCGS. The Biological Opinion also formalized ice barrier removal from May 1 through October 24 by making it a requirement in the "Terms and Conditions" section of the Biological Opinion. In order to implement the 1999 Biological Opinion, PSEG developed associated guidance documents, *Biological Opinion Compliance* (PSEG, 1999a) and *Species Management* (PSEG, 1999c).

Table 3 provides a summary of the incidental take limits for each Biological Opinion that NMFS issued, including the current 1999 Biological Opinion take limits. Neither the leatherback sea turtle nor the Atlantic sturgeon have been included in previous assessments of Salem and HCGS impacts or in previous Biological Opinions.

Table 3. Salem and HCGS Incidental Take Statement Limits

	Annual Take Limit Set by NMFS Biological Opinions[a]				
Species	**1980**	**1991**	**1992**	**1993**	**1999**
loggerhead sea turtle	-	10 (5)	30 (5)	30 (5)	30 (5)
green sea turtle	-	5 (2)	5 (2)	5 (2)	5 (2)
Kemp's ridley sea turtle	-	5 (1)	5 (1)	5 (1)	5 (1)
shortnose sturgeon	11	2 (2)	10 (2)	10 (10)	5 (5)

[a]The number given is the total number of allowable takes followed in parentheses by the number of takes out of the total that may be lethal takes.

Sources: NMFS, 1993; NMFS, 1999

2.4.2 Current Biological Opinion Limits and Conditions

The current Biological Opinion (NMFS, 1999)'s Incidental Take Statement was amended on January 21, 1999, and allows Salem and HCGS to incidentally take up to the following number of individual listed species:

- 30 loggerheads (of which, up to 5 may be injured or dead),
- 5 green sea turtles (of which, up to 2 may be injured or dead),
- 5 Kemp's ridleys (of which, up to 1 may be injured or dead), and
- 5 shortnose sturgeon (of which, up to 5 may be injured or dead).

The Biological Opinion also contains the following "Reasonable and Prudent Measures," which apply to Salem:

- Removable ice barriers located on the trash racks must be removed by May 1 of each year and replaced after October 24 of each year,
- Trash racks associated with Salem's circulating water system must be cleaned three times per week from May 1 through November 15 and must be cleaned daily from June 1 through October 15,
- Trash racks must be inspected every two hours from June 1 through October 15, and

- If a lethal incidental take that is directly attributable to the plant occurs between June 1 and October 15, monitoring of the trash racks must be increased to hourly for the remainder of the year.

The Biological Opinion does not contain "Reasonable and Prudent Measures" specific to HCGS. The previous Biological Opinion (NMFS, 1993) concluded that HCGS would not affect listed species because no species had been documented at the site between when the plant began operating in 1986 and the issuance of the Biological Opinion in 1993, and the 1993 Biological Opinion did not require monitoring at HCGS beyond normal cleaning operations. The 1999 Biological Opinion did not modify any requirement specific to HCGS.

The "Terms and Conditions" portion of the Biological Opinion requires PSEG to report all incidental takes to NMFS within 30 days of the take and to include appropriate documentation in the report. Additionally, the "Terms and Conditions" detail a number of requirements for sea turtle resuscitation, live sea turtle inspection, dead sea turtle necropsy reports, shortnose sturgeon tagging and inspection.

3.0 Proposed Action Area: the Delaware Estuary

From the mouth of Delaware Bay upstream through the estuary and to the river, the aquatic environment transitions from saltwater, to tidally influenced brackish water of variable salinity, and then to tidal freshwater. Brackish and saltwater marshes occur along the margins of the estuary. The estuary's substrate provides a range of benthic habitats with characteristics dictated by salinity, tides, water velocity, and sediment type. Sediments in the estuary zone surrounding Artificial Island are primarily mud, muddy sand, and sandy mud (PSEG, 2006b).

At Artificial Island, the estuary is tidal with a net flow to the south. The USACE maintains a dredged navigation channel near the center of the estuary about 6,600 ft (2,000 m) west of the shoreline at Salem and HCGS. The navigation channel is about 40 ft (12 ft) deep and 1,300 ft (400 m) wide. On the New Jersey side of the channel, water depths in the open estuary at mean low water are fairly uniform at about 20 ft (6 m). Predominant tides in the area are semi-diurnal, with a period of 12.4 hours (hrs) and a mean tidal range of 5.5 ft (1.7 m). Tidal currents flow fastest in the channel and more slowly in shallower areas (NRC, 1984; Najarian Associates, 2004).

Salinity is an important determinant of biotic distribution in estuaries, and salinity near the Salem and HCGS facilities varies with river flow. NRC (1984) reported that average salinity in this area during periods of low flow ranged from 5 to 18 parts per thousand (ppt; .005 to .018 milligrams per liter [mg/L]) and during periods of higher flow ranged from 0 to 5 ppt (0 to 0.005 mg/L). Najarian Associates (2004) and PSEG (2005) characterized salinity at HCGS as ranging from 0 to 20 ppt (0 to .02 mg/L) and typically exceeding 6 ppt (0.006 mg/L) in summer during periods of low flow. Based on temperature and conductivity data collected by the USGS at Reedy Island just north of Artificial Island, Najarian Associates (2004) calculated salinity from 1991 through 2002. Their data indicate that salinity during the study period had a median of about 5 ppt (0.005 mg/L); exceeded 12 ppt (0.012 mg/L) in only two years and 13 ppt (0.013 mg/L) in only one year; and never exceeded 15 ppt (0.015 mg/L) during the entire 11-year period. Based on these observations, NRC staff assumes that salinity in the vicinity of Salem and HCGS is typically from 0 to 5 ppt (0 to 0.005 mg/L) in periods of low flow (usually, but not always, summer) and 5 to 12 ppt (0.005 to 0.012 mg/L) in periods of high flow. Within these larger patterns, salinity at any specific location also varies with the tides (NRC, 2007).

Monthly average surface water temperatures in the Delaware Estuary vary with season. Between 1977 and 1982, water temperatures ranged from 30.4 degrees Fahrenheit (°F; -0.89 degrees Celsius [°C]) in February 1982 to 86.9 °F (32.0 °C) in August 1980. Although the estuary in this reach is generally well mixed, it can occasionally stratify, with surface temperatures 2 °F to 4 °F (1 °C to 2 °C) higher than bottom temperatures and salinity increasing as much as 2.0 ppt (0.002 mg/L) per 3.3 ft (1.0 m) of water depth (NRC, 1984).

The estuary reach adjacent to Artificial Island is at the interface of the oligohaline and mesohaline zones, based on Cowardin et al. (1979)'s estuary classification criteria. Thus, the estuary reach bordering Salem and HCGS is oligohaline during high flow and mesohaline during low flow conditions. Based on water clarity categories of good, fair, or poor, the EPA (1998) classified the water clarity in this area of the estuary as generally fair (meaning that a wader in waist-deep water would not be able to see his feet). The EPA classified the water clarity directly upstream and downstream of this reach as poor (meaning that a diver would not be able to see his hand at arm's length). EPA (1998) classified most estuarine waters in the Mid-Atlantic as having good water clarity and stated that lower water clarity typically is due to phytoplankton blooms and suspended sediments and detritus.

The Delaware Bay is a complex estuary, with many individual species playing different roles in the system, and often, species play several ecological roles throughout their lifecycles. Major assemblages of organisms within the estuarine community include plankton, benthic invertebrates, and fish. Detailed descriptions of these assemblages can be found in Section 2.2.5 of the NRC (2010a)'s draft SEIS for Salem and HCGS.

4.0 Federally Listed Species Considered

NMFS (2010) identified five aquatic species under its jurisdiction that are Federally listed as threatened or endangered and one species that is listed as a candidate that may occur in the Delaware Estuary in the vicinity of the Salem and HCGS facilities. These species are listed in Table 4 and also described in detail in the following sections.

Table 4. Threatened, Endangered, and Candidate Aquatic Species of the Delaware Estuary in the Vicinity of Salem and HCGS.

Scientific Name	Common Name	Federal Status[1]
Reptiles		
Caretta caretta	loggerhead sea turtle	T
Chelonia mydas	green sea turtle	T
Lepidochelys kempii	Kemp's ridley sea turtle	E
Dermochelys coriacea	leatherback sea turtle	E
Fish		
Acipenser brevirostrum	shortnose sturgeon	E
A. oxyrinchus oxyrinchus	Atlantic sturgeon	C

[1]C = candidate; E = endangered; T = threatened

Source: NMFS, 2010

4.1 Loggerhead Sea Turtle

Species Description

The Federally threatened loggerhead turtle has a slightly elongated, heart shaped carapace that tapers towards the posterior and has a broad, triangular head (Pritchard et al., 1983). Loggerheads normally weigh up to 450 pounds (lb; 200 kilograms [kg]) and attain a straight carapace length of up to 48 in. (120 cm) (Pritchard et al., 1983). Their general coloration is reddish-brown dorsally and creamy-yellow ventrally (Hopkins and Richardson, 1984). Morphologically, the loggerhead is distinguishable from other sea turtle species by the following characteristics: 1) a hard shell; 2) two pairs of scutes on the front of the head; 3) five pairs of lateral scales on the carapace; 4) plastron with three pairs of enlarged scutes connecting the carapace; 5) two claws on each flipper; and, 6) reddish-brown coloration (Nelson, 1988; Dodd, 1988; Wolke and George, 1981).

Loggerheads reach sexual maturity at about 35 years of age (NOAA, 2010e). Females nest on sandy, ocean beaches every other to every third year from April through September along the southeastern coast of the U.S., and nesting usually peaks in late June and July (Dodd, 1988; Hopkins and Richardson, 1984). Females lay 2 to 3 clutches of eggs per nesting year, and each clutch consists of 35 to 180 eggs (Hopkins and Richardson, 1984). The eggs hatch in 46 to 68 days, and 2-in. (5-cm) hatchlings emerge at night, move rapidly towards the water, and swim out to sea (Hopkins and Richardson, 1984). Loggerhead hatchlings are brown dorsally with light margins ventrally and have five pairs of lateral scales (Pritchard et al., 1983). Many hatchlings fall prey to sea birds and other predators following emergence. Those hatchlings that reach the water quickly move offshore and remain in the open sea until maturity (Carr, 1986).

Distribution and Habitat

Loggerhead turtles are circumglobal, inhabiting continental shelves, bays, lagoons, and estuaries in the temperate, subtropical and tropical waters of the Atlantic, Pacific, and Indian Oceans (Dodd, 1988; Mager, 1985). In the western Atlantic Ocean, loggerhead turtles occur from Argentina northward to Newfoundland including the Gulf of Mexico and the Caribbean Sea (Dodd, 1988; Mager, 1985; Nelson, 1988). Sporadic nesting is reported throughout the tropical and warmer temperate range of the species' distribution, but the most important nesting areas are the Atlantic coast of Florida, Georgia, and South Carolina (Hopkins and Richardson, 1984).

Loggerheads occupy three types of habitat during their lifecycle: oceanic beaches, deep water ocean, and nearshore ocean (NOAA, 2010e). Loggerheads begin their lives on coastal beaches when hatchlings emerge from the nest. Hatchlings quickly move towards the water and are swept through the surf zone and into deeper ocean water. Between the ages of 7 to 12 years old, juveniles migrate to nearshore coastal areas, which provides foraging habitat. Loggerheads are primarily carnivorous and eat a variety of benthic organisms that are found nearshore, including mollusks, crabs, shrimp, jellyfish, sea urchins, sponges, squids, and fishes (Nelson, 1988; Seney et al., 2002). Adult loggerheads occupy a combination of all three zones during their migration from foraging habitats to nesting beaches. Some populations stay along the continental shelf during their migration routes, while other populations migrate through deep water to and from the Bahamas, Cuba, and the Yucatan Peninsula (NOAA, 2010e).

Population Trends and ESA Listing History

The FWS listed the loggerhead on the Federal List of Endangered and Threatened Wildlife under the ESA on July 28, 1978 (43 FR 323800). In 1985, the NMFS conducted a five-year review (Mager, 1985) for the species based on estimates of nesting female populations. Mager (1985) considered 52 populations throughout the Atlantic, Pacific, and Indian Oceans and concluded that 33 of the 52 populations were declining; 18 were of unknown status; and 1 population, the southeast U.S. Atlantic population, was increasing. The FWS conducted a second five-year review (56 FR 56882) in 1991 that assessed multiple species in addition to the loggerhead within the review. No change in the loggerhead's listing status resulted from the 1991 status review. In 1995, NMFS and FWS conducted a third five-year review (Plotkin, 1995), which indicated that the number of nesting females in South Carolina and Georgia was declining at a rate of 5 percent and 3 percent per year, respectively. Data on the Florida loggerhead population, which accounts for over 90 percent of loggerhead nesting activity, indicated that it was stable, but that increasing human presence near nesting habitat could impact the population in the future (Plotkin, 1995). NMFS and FWS (2007d) conducted a fourth five-year review of the loggerhead in 2007, which indicated that loggerhead populations may be able to be separated by distinct population segments (DPSs) based on ocean basins. In accordance with the NMFS and FWS's 1996 DPS policy (61 FR 4722), NMFS and FWS convened a Loggerhead Biological Review Team in February 2008 to review the newly available information on loggerhead populations and determine if the DPS criteria applied to the species. Conant et al. (2009a) published a status review associated with this effort, which identified nine loggerhead DPSs distributed throughout the globe. On March 16, 2010, the NMFS published a proposed rule to list 9 loggerhead DPSs under the ESA (75 FR 12598). The proposed rule identifies the Northwest Atlantic DPS, which includes those loggerheads nesting along the coasts of North America, Central America, northern South America, the Antilles, and The Bahamas, as an endangered DPS. This DPS constitutes the most significant nesting assemblage of loggerheads in the western hemisphere and would include those loggerheads that migrate as far north as New Jersey.

4.2 Green Sea Turtle

Species Description

The Federally threatened green sea turtle is the largest of the hard-shelled sea turtles, but has a small, nearly oval carapace and a small, rounded head (Pritchard et al., 1983). Its carapace is olive brown in color with darker streaks and spots, and its plastron is yellow. Full grown adult green turtles weigh 220 to 330 lb (100 to 150 kg) and attain a straight carapace length of 35 to 40 in. (90 to 100 cm) (Pritchard et al., 1983; Hopkins and Richardson, 1984; Witherington and Ehrhart, 1989). Morphologically, this species can be distinguished from the other sea turtles by the following characteristics: 1) a relatively smooth shell with no overlapping scutes; 2) one pair of scutes on the front of the head; 3) four pairs of lateral scutes on the carapace; 4) plastron with four pairs of enlarged scutes connecting the carapace; 5) one claw on each flipper; and, 6) olive, dark brown mottled coloration (Nelson, 1988; Pritchard et al., 1983).

Green turtles reach sexual maturity at 20 to 50 years of age (NOAA, 2010b). In the southeastern U.S., females nest between June and September, with peak nesting between June and July (NOAA, 2010b). Although males mate annually, females only nest every two to four years (NOAA, 2010b). Mature females may nest 1 to 7 times per season at about 10- to 18-day intervals (Carr et al., 1978). Average clutch size varies between 100 and 200 eggs, and eggs usually hatch within 45 to 60 days (Hopkins and Richardson, 1984). Hatchlings emerge at night, travel quickly to water, and swim out to sea. Hatchlings are about 0.88 ounces (oz; 25 grams [g]), 2.2 in. (5.5 cm) long, and have a black carapace that is white on the ventral side. As with loggerhead hatchlings, many green hatchlings are attacked by predators before reaching the ocean. Those hatchlings that reach the water quickly move offshore and remain in the open sea until maturity.

Distribution and Habitat

Atlantic green turtles are circumglobally distributed mainly in waters between the northern and southern 68 °F (20 °C) isotherms (Mager, 1985) and may inhabit the coastal waters of over 140 countries (NMFS and FWS, 2007a). In the western Atlantic, several major assemblages have been identified and studied (Parsons 1962; Pritchard, 1966; Schulz, 1975; 1982; Carr et al., 1978). In U.S. Atlantic waters, green turtles are found around the U.S. Virgin Islands, Puerto Rico, and the continental United States from Texas to Massachusetts (NMFS and FWS, 1991). Nesting grounds extend from Texas to North Carolina, as well as in the U.S. Virgin Islands and Puerto Rico, and important feeding ground within the U.S. Atlantic and Gulf of Mexico includes the Indian River Lagoon, the Florida Keys, Florida Bay, Crystal River, and St. Joseph Bay (NOAA, 2010b). Critical habitat is designated in waters around Isla Culebra, Puerto Rico (NOAA, 2010b).

Green turtles occupy three types of habitat during their lifecycle: oceanic beaches, convergence zones in the open ocean, and nearshore benthic feeding grounds. Green turtles begin their lives on coastal beaches when hatchlings emerge from the nest. Hatchlings quickly move towards the water and swim to offshore to open ocean, where they remain for several years (NOAA, 2010b). Post-hatchlings are most likely omnivorous and eat a combination of pelagic plants and animals (NOAA, 2010b). Upon reaching a straight carapace length of about 8 to 10 in. (20 to 25 cm), green turtles move closer to shore into benthic foraging areas (Mager, 1985). Adults are almost exclusively herbivores and eat sea grasses and algae, though they also may consume jellyfish, sponges, and other organisms living on sea grass blades and algae (Mager, 1985; NMFS and FWS, 1991). Adult females migrate up to thousands of miles from benthic foraging areas to mainland or island beaches to nest every two to four years (NOAA, 2010b).

Population Trends and ESA Listing History

The FWS listed the green sea turtle on the Federal List of Endangered and Threatened Wildlife under the ESA on July 28, 1978 (43 FR 323800), and the NMFS and FWS published a recovery plan for the U.S. green turtle population in 1991 (NMFS and FWS, 1991). In 2004, the International Union for Conservation of Nature (IUCN)'s Marine Turtle Specialist Group report that a 48 to 65 percent decline in the number of mature nesting females has occurred in all major ocean basins over the past 100 to 150 years (Seminoff, 2004). In 2007, the NMFS and FWS published a five-year review of the green sea turtle (NMFS and FWS, 2007a). The NMFS and FWS (2007a) reported that out of 23 major nesting sites, 10 nesting populations were increasing, 9 were stable, and 4 were decreasing. Within the western Atlantic Ocean, NMFS and FWS (2007a) reported that four of the six major nesting rookeries had shown population increases, and data for the other two nesting rookeries indicated that the populations were stable. However, the report noted that because of the green sea turtle's long lifespan and the lack of long-term data at the majority of the sites, this information may be misleading (NMFS and FWS, 2007a). In the five-year review, the NMFS and FWS (2007a) recommended that the green sea turtle remain listed under the ESA, but that a review of the species should be conducted to determine the applicability of the 1996 DPS policy (61 FR 4722) to the species.

4.3 Kemp's Ridley Sea Turtle

Species Description

The Federally endangered Kemp's ridley is the smallest of living sea turtle species. Adults weigh up to 90 lb (42 kg) and attain a straight carapace length up to 27 in. (70 cm) (Pritchard et al., 1983). The Kemp's ridley has a circular carapace and a medium-sized pointed head with olive-green coloration on its dorsal side and yellow coloration on its ventral side (Hopkins and Richardson, 1984). Morphologically, the Kemp's ridley is distinguishable from other sea turtle species by the following characteristics: 1) a hard shell; 2) two pairs of scutes on the front of the head; 3) five pairs of lateral scutes on the carapace; 4) plastron with four pairs of scutes with pores, connecting the carapace; 5) one claw on each front flipper and two on each back flipper; and, 6) olive green coloration (Pritchard et al., 1983; Pritchard and Marquez, 1973).

Kemp's ridleys reach sexual maturity between the ages of 10 and 15 years (IUCN Marine Turtle Specialist Group, 2010). Females lay 2 to 3 clutches of about 100 eggs each between May and July along the coast near Rancho Nuevo, Tamaulipas, Mexico (Pritchard and Marquez, 1973; Hopkins and Richardson, 1984). During the nesting season, females aggregate onshore in large groups to lay eggs (NOAA, 2010c). The species' synchronized nesting behavior may be triggered by offshore winds, lunar cycles, and the release of pheromones, but is a phenomenon that is not well understood by scientists (NOAA, 2010c). Kemp's ridley eggs hatch in 45 to 70 days, and 1.5-in. (3.8-cm) hatchlings emerge 2 to 3 days later (Hopkins and Richardson, 1984; NOAA, 2010c). Hatchlings weigh about 0.5 oz (14 g) and are dark grey-black dorsally and white ventrally (Pritchard et al., 1983; Pritchard and Marquez, 1973). Hatchings move quickly towards the ocean once they hatch, though many are attacked by predators before reaching the ocean. Those hatchlings that reach the water quickly move offshore and remain in the open sea until maturity.

Distribution and Habitat

The Kemp's ridley has the most restricted geographical range of the sea turtle species because they are only known to primarily nest in one main beach area—Rancho Nuevo, Tamaulipas, Mexico (Pritchard and Marquez, 1973; Hopkins and Richardson, 1984). Females occasionally use two additional nesting grounds in Padre Island, Texas, and Veracruz, Mexico (Mager, 1985; Turtle Expert Working Group, 2000). Adults migrate through the Gulf of Mexico, the Caribbean, and the northwest Atlantic Ocean.

Kemp's ridleys inhabit nearshore habitat that contains muddy or sandy bottoms that support their prey—swimming crabs, small fish, jellyfish, and mollusks (NOAA, 2010c). Adults occupy deeper ocean only during migration, and Plotkin (1995) suggested that Kemp's ridleys rarely occupy waters deeper than 160 ft (50 m). Some males migrate annually within the Gulf of Mexico between feeding and breeding grounds, while other males do not migrate at all (NOAA, 2010c). Females migrate through foraging areas between the Yucatan Peninsula to southern Florida and return to beach habitat along the coast of Mexico to nest (NOAA, 2010c).

Population Trends and ESA Listing History

The FWS listed the Kemp's ridley on the Federal List of Endangered and Threatened Wildlife under the ESA on December 2, 1970 (35 FR 18319), and NMFS and FWS published a recovery plan for the species in 1992 (NMFS and FWS, 1992). In 1977, the FWS and Mexican Government began a cooperative program to take about 2,000 eggs per year from Rancho Nuevo, hatch Kemp's ridley eggs in captivity, and release them once they had passed through vulnerable life stages (NMFS, 1994). This "headstart" program was controversial among sea turtle biologists. Between 1947 and 1992, the population of nesting females in Rancho Nuevo declined by over 98 percent, from a documented 40,000 females during a single breeding event to less than 500 (NMFS, 1994). By 1985, the estimated number of nesting females had declined even further to approximately 234 turtles (NMFS and FWS, 2007b). The nesting female population remained well below 1,000 during the 1980s, but began to increase in the 1990s. Plotkin (1995) reported that juvenile Kemp's ridleys were appearing in the northern Gulf of Mexico, whereas Kemp's ridleys had not been encountered in this area when initial surveys of the species had been completed in the 1950s. By 2002, the FWS reported over 6,000 nests in Tamaulipas and Veracruz, which equates to approximately 1,897 nesting females (NMFS and FWS, 2007b). In a five-year review of the species, the NMFS and FWS (2007b) reported that an estimated 12,143 females nested in Mexico in 2006, and an additional 100 nests were recorded in the U.S., primarily in Texas. In the five-year review, the NMFS and FWS (2007b) recommended that the Kemp's ridley sea turtle remain listed under the ESA as endangered, but that the recovery plan for the species be updated based upon newly available scientific information. NOAA issued a *Draft Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii), Second Revision*, for public comment on March 16, 2010 (75 FR 12496). The draft recovery plan (NMFS and FWS, 2010) predicts that, assuming current survival rates remain constant and based on data from Heppel et al. (2005), the Kemp's ridley population with grow between 12 and 16 percent per year and could reach 10,000 nesting females per season by 2015.

4.4 Leatherback Sea Turtle

Species Description

The Federally endangered leatherback sea turtle is the largest living sea turtle and is the only sea turtle that does not have a hard, bony shell. It has an elongated, somewhat triangularly shaped body with longitudinal ridges or keels. It has a leathery, blue-black shell composed of a thick layer of oily, vascularized, cartilaginous material, strengthened by a mosaic of thousands of small bones. Its blue-black shell may also have variable white spotting, and its plastron is white. Leatherbacks can weigh up to 2,000 lb (900 kg) and attain a straight carapace length of 55 in. (140 cm) (NOAA, 2010d; Pritchard et al., 1983; Hopkins and Richardson, 1984). Morphologically, this species can be easily distinguished from the other sea turtles by the following characteristics: 1) its smooth unscaled carapace with seven longitudinal ridges; 2) head and flippers covered with unscaled skin; and, 3) no claws on the flippers (Nelson, 1988; Pritchard et al., 1983; Pritchard, 1971).

Leatherbacks reach sexual maturity at the age of 12 to 15 years. Leatherbacks mate in waters adjacent to nesting grounds, and the species nests around the world including along the coasts of northern South America, west Africa, the U.S. Caribbean, the U.S. Virgin Islands, and southeast Florida (NOAA, 2010d). Females nest from late February or March to September 1 to 9 times per season at about 9- to 17-day intervals (Hopkins and Richardson, 1984). Females lay between 50 and 170 eggs, which hatch within 50 to 75 days (Hopkins and Richardson, 1984). Two to 3-in. (50- to 77-cm) hatchlings weighing 1.4 to 1.8 oz (40 to 50 g) emerge at night, travel quickly to the water, and swim out to sea.

Distribution and Habitat

Leatherbacks are circumglobally distributed and occur in the Atlantic, Indian, and Pacific Oceans. They range as far north as Labrador, Canada, and the state of Alaska to as far south as Chile and the Cape of Good Hope. The leatherback is highly migratory, and tagged females have been found to migrate from French Guiana to the east coast of North America and as far north as Newfoundland (NOAA, 2010d). The species is able to maintain a body temperature warmer than the surrounding seawater over a long period of time due to its counter-current body heat exchange, high oil content, and large body size, and these adaptations likely accounts for its occurrence farther north than other sea turtle species (NOAA, 2010d). Shoop et al. (1981) reported that, from April to November, leatherbacks occur from North Carolina to north to Nova Scotia but that during the summer months, leatherbacks are most likely to restrict their range from the Gulf of Maine south to Long Island. The NMFS designated critical habitat for the species in the coastal waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands (44 FR 17710).

Leatherbacks spend the majority of their lives in deep, open ocean, but may also forage in coastal waters. The diet of the leatherback consists primarily of soft-bodied animals such as jellyfish and tunicates, together with juvenile fishes, amphipods, and other organisms, which can be found in either coastal areas or deeper ocean (Hopkins and Richardson, 1984). The habitat preferences of juvenile leatherbacks are not well understood, though Eckert (2002) noted that leatherbacks smaller than 39 in. (100 cm) are only sighted in waters warmer than 79 °F (26 °C).

Population Trends and ESA Listing History

The FWS listed the leatherback on the Federal List of Endangered and Threatened Wildlife under the ESA on June 2, 1970 (35 FR 8491). Pritchard (1982) estimated the worldwide population of leatherbacks to be 115,000 individuals based on estimates from nesting female surveys. In January 1996, NOAA published a notice of availability of a status review of the species (61 FR 17). In the review, Plotkin (1995) noted that the species population had declined since Pritchard's 1982 estimate and that available data indicated that only 20,000 to 30,000 females remained. Plotkin (1995) concluded that it was unknown whether leatherback populations under U.S. jurisdiction were stable, increasing, or decreasing, but that some U.S. nesting populations, such as those in St. John and St. Thomas, U.S. Virgin Islands, were near extirpation. In 1998, the NMFS and FWS published a recovery plan for the Pacific population of leatherbacks (63 FR 28359). No such recovery plan has been published for the Atlantic population. In the 2007 five-year review of the species NMFS and FWS (2007c) indicated that the Atlantic population within Florida has shown an increase in nests from 98 in 1988 to 800 to 900 in the early 2000s. Nesting also increased in Puerto Rico, the U.S. Virgin Islands, and the British Virgin Islands from the 1980s to the 2000s (NMFS and FWS, 2007c). However, Leatherback nesting along the Costa Rica Atlantic coast decreased 67.8 percent from 1995 to 2006 (NMFS and FWS, 2007c). In 2007, the Turtle Expert Working Group (2007) estimated the Atlantic population to be between 34,000 and 94,000 individuals strong. The species has not been officially divided into DPSs, but in the most recent five-year review, the NMFS and FWS (2007c) recommended that the leatherback sea turtle remain be reviewed to specifically determine the applicability of the 1996 DPS policy (61 FR 4722) to the species.

4.5 Shortnose Sturgeon

Species Description

The shortnose sturgeon is an anadromous, primitive bonyfish that can be differentiated by other sturgeon species by its smaller size and shorter and blunter nose than other sturgeon species. Shortnose sturgeons grow to a length of 4.7 ft (1.4 m) and typically weigh up to 50.7 lb (23 kg) (NOAA, 2010f). Juveniles mature into adults at a fork length of 18 to 22 in. (45 to 55 cm), which, in the Delaware River, coincides to about 3 to 5 years of age in males and 6 to 7 years of age in females (NOAA, 2010f). The shortnose's lifespan varies from 30 years (males) to 67 years (females).

The shortnose sturgeon migrates earlier in the year than other Atlantic sturgeon species. Adults begin to migrate upstream to freshwater beginning in the winter, spend most of the winter in deep waters of rivers and estuaries, and spawn between January and mid-May (Dadswell et al., 1984). Water temperature is a major determining factor of spawning time, and shortnose begin to spawn when water temperatures reach 46 to 48 °F (8 to 9 °C) (Gilbert, 1989), which in the Delaware Estuary is early to mid-April (NODC, 2010). Females produce 40,000 to 200,000 dark brown to black-colored eggs each spring and lay their eggs in faster flowing waters over rock, rubble, or hard clay substrate (Gilbert, 1989). Eggs are separate when spawned, but become adhesive within 20 minutes of being fertilized and adhere to hard substrates on the river bottom (Dadwell et al., 1984). Eggs hatch in 4 to 15 days with incubation time being inversely correlated with water temperate; eggs hatch in 8 days at 63 °F (17 °C) and in 13 days at 50 °F (10 °C) (Gilbert, 1989). Larvae consume their yolk sac and begin feeding in 8 to 12 days, as they migrate downstream and away from the spawning site (Kynard, 1997; Colette and Klein-MacPhee, 2002). Juveniles, which feed on benthic insects and crustaceans, remain in freshwater until the following winter, at which time they migrate to brackish estuaries, where they remain for 3 to 5 years. Shortnose sturgeon are considered adults at a fork length of 18 to 22 in. (45 to 55 cm) and age of 3 to 10 years (Gilbert, 1989). As adults, they migrate to the nearshore marine environment, where their diet consists of mollusks and large crustaceans (Shepard, 2006).

Distribution and Habitat

Shortnose sturgeons inhabit rivers, estuaries, and nearshore marine environments. The species spawns in coastal rivers along the Atlantic coast from St. Johns River, New Brunswick, Canada, south to St. Johns River, Florida (NOAA, 2010f). Shortnose occur in most major river systems along the Atlantic coast, including the Savannah River, Georgia; the Chesapeake Bay system; the Delaware River; the Hudson River, New York; the Connecticut River; and the lower Merrimack River, Massachusetts (NOAA, 2010f).

Sturgeon larvae hatch in freshwater, and juveniles migrate from freshwater riverine environments to brackish estuarine environments between the ages of 3 to 5 years. Adults inhabit nearshore marine areas and are not believed to travel long distances offshore during their annual migration routes (NOAA, 2010f).

Population Trends and ESA Listing History

No historical population estimates are available for the shortnose sturgeon. Though the species has never been widely commercially fished, the species was often incidentally taken in fishing gear, and by the 1950s, the lack of recorded shortnose landings led the FWS to conclude that the species was in danger of extinction (NOAA, 2010f). The FWS listed the shortnose sturgeon on the Federal List of Endangered and Threatened Wildlife under the ESA on March 11, 1967 (32 FR 4001). In the 1980s, Hastings et al. (1987) estimated the Delaware River population to be 6,408 to 14,080 adults. This estimate suggested that the Delaware River shortnose population was one of the healthiest at the time; however, because these estimates did not account for recruitment and migration rates between population segments, it was unclear whether the estimates truly represented the total population in the river (SSRT, 1998; Pyle, 2005). A Recovery Plan (SSRT, 1998) was developed for the species in 1998, which recognized 19 distinct population segments along the Atlantic Coast because shortnose sturgeon return to their natal rivers to spawn each year, which results in minimal genetic intermixing (SSRT, 1998). The Recovery Plan did not provide any updated information specific to the Delaware River population. The NMFS initiated a status review of the shortnose sturgeon on November 30, 2007 (72 FR 67712). The NMFS expected to complete the status review in 2009 (NOAA, 2009); however, the deadline for providing comments pertaining to the review was extended on January 29, 2008 (73 FR 5177), and to date, this status review has not been published.

4.6 Atlantic Sturgeon

Species Description

The Atlantic sturgeon is an anadromous bonyfish that can grow to 14 ft (4.3 m) and weigh up to 800 lbs (370 kg) (Gilbert, 1989; NOAA, 2010a). Atlantic sturgeon are similar in appearance to shortnose sturgeon—bluish-black to olive brown dorsally with pale sides and underbelly—but are larger in size and have a smaller and differently shaped mouth (NOAA, 2010a). Females reach maturity at 7 to 30 years of age, and males reach maturity at 5 to 24 years of age, with those fish inhabiting the southern range maturing earlier (ASMFC, 2007).

In the mid-Atlantic, adults migrate upriver from April to May to spawn. Females in the Delaware River produce 0.8 to 2.4 million highly adhesive eggs, which fall to the bottom of the water column and adhere to cobble or other hard bottom substrate (ASSRT, 2007; Gilbert, 1987). Eggs hatch in 94 to 140 hours at temperatures of 20 °C (68 °F) and 18 °C (64.4 °F), respectively (ASSRT, 2007). Larvae consume their yolk sac in 8 to 12 days, during which time larvae migrate downstream into brackish water, where they live for a few months (ASSRT, 2007). When juveniles reach a size of 30 to 36 in. (76 to 92 cm), they migrate to nearshore coastal waters, where they feed on benthic invertebrates, including crustaceans, worms, and mollusks (NOAA, 2010a).

Distribution and Habitat

Historically, the Atlantic sturgeon has inhabited riverine, estuarine, and coastal ocean waters from St. Lawrence River, Canada, to St. John's River, Florida (ASMFC, 2009). However, within the U.S., the species is only known to remain in the Hudson River, Delaware River, and a few South Carolina river systems (ASMFC, 2009).

Atlantic sturgeon larvae hatch in freshwater, and larvae migrate from freshwater to brackish estuarine environments, where they remain for a few months to a few years (NOAA, 2010a). Juveniles and non-spawning adults inhabit estuaries and coastal marine waters dominated by gravel and sand substrates (NOAA, 2010a).

Population Trends and ESA Listing History

Atlantic sturgeon have been commercially fished from as early as 1628, though a substantial Atlantic sturgeon fishery did not appear until the late 1800s (Shepard, 2006). Overfishing and habitat degradation caused a decline in landings beginning in the early

1900s; however, landings increased from 1950 to 1980, specifically in the Carolinas, and ranged from 45 metric tons per year (mt/yr) to 115 mt/yr (Shepard, 2006). In 1998, the Atlantic States Marine Fisheries Commission, which manages the commercial harvest of the species, instituted a moratorium on Atlantic sturgeon harvest in U.S. waters until the population grows to at least 20 protected age classes in each spawning stock, which may take up to 40 years (NOAA, 2010a). Today, the species is still caught as bycatch. Based on data from 2001 to 2006, the ASMFC (2007) estimated that between 2,752 and 7,904 individuals per year are caught as bycatch in sink gillnets, and 2,167 to 7,210 individuals per year are caught as bycatch in trawls. In a 2007 Status Review of the species, the Atlantic Sturgeon Status Review Team (2007) noted that little is known about the size and spawning of the Delaware River population, but that the current population has been greatly reduced within all life stages.

In 2007, the NMFS considered listing the Atlantic sturgeon under the ESA, but concluded that listing was not warranted at that time. In 2009, the Natural Resources Defense Council petitioned for the NMFS to reconsider the listing of the species (NRDC, 2009). The NMFS accepted the NRDC's petition in a 90-Day Finding on January 6, 2010 (75 FR 838). On October 6, 2010, the NMFS published Proposed Listing Determinations for five Atlantic sturgeon DPSs (75 FR 61872; 75 FR 61904). Atlantic Sturgeon found within the vicinity of Salem and HCGS in the Delaware Estuary are part of the proposed New York Bight DPS, which includes the Long Island Sound, the New York Bight, and the Delaware Bay from Chatham, Massachusetts, to the Delaware-Maryland border.

5.0 Proposed Action Effects Analysis

Salem and HCGS may affect Federally listed species in the Delaware Estuary by:

1) **Impingement of listed individuals as juveniles or adults at the facilities' water intake points.** Impingement occurs when aquatic organisms are pinned against intake screens or other parts of the cooling water system intake structure.
2) **Entrainment of eggs or larvae of listed species at the facilities' water intake points.** Entrainment occurs when aquatic organisms (usually eggs, larvae, and other small organisms) are drawn into the cooling water system and are subjected the thermal, physical, and chemical stress.
3) **Heat shock from the discharge of heated water at the facilities' discharge points.** Heat shock is acute thermal stress caused by exposure to a sudden elevation of water temperature that adversely affects the metabolism and behavior of fish and other aquatic organisms.

This section summarizes historical incidental takes of listed species, incidental takes of species since issuance of the current Biological Opinion (NMFS, 1999), and expected impacts to each listed species during the remaining 6, 10, and 16-year period of operation for Salem, Unit 1; Salem, Unit 2; and HGCS, respectively, as well as the proposed 20-year relicensing period.

5.1 Historical Incidental Takes of Listed Species

HCGS has not reported any impingement of listed species in its intake since it began operating in 1986 (PSEG, 2009b), and thus, has no historical impingement records.

Salem's historical impingement data prior to NMFS's issuance of the most recent Biological Opinion (NMFS, 1999) is summarized by species and year in Table 5.

Table 5. Historical Incidental Takes of Listed Species at Salem, 1979-1998

Year	Number Impinged[(a)]					
	Loggerhead Sea Turtle	Green Sea Turtle	Kemp's Ridley Sea Turtle	Leatherback Sea Turtle	Shortnose Sturgeon	Atlantic Sturgeon
1978	-	-	-	-	2 (2)	-
1979	-	-	-	-	-	-
1980	2 (2)	-	1 (0)	-	-	-
1981	3 (2)	-	1 (1)	-	1 (1)	-
1982	1 (1)	-	-	-	-	-
1983	2 (2)	-	1 (1)	-	-	-
1984	2 (2)	-	1 (0)	-	-	-
1985	6 (5)	-	2 (1)	-	-	-
1986	-	-	1 (1)	-	-	-
1987	3 (0)	-	3 (2)	-	-	-
1988	8 (6)	-	2 (1)	-	-	-
1989	2 (0)	-	6 (2)	-	-	-
1990	-	-	-	-	-	-
1991	23[(b)] (1)	1 (0)	1 (0)	-	3 (3)	-
1992	10 (0)	1 (1)	4 (2)	-	2 (2)	-
1993	-	-	1 (0)	-	-	-
1994	1 (0)	-	-	-	2 (2)	-
1995	1 (1)	-	-	-	-	-
1996	-	-	-	-	-	-
1997	-	-	-	-	-	-
1998	1 (1)	-	-	-	3 (1)	-
TOTAL	**65 (24)**	**2 (1)**	**24 (11)**	**0 (0)**	**13 (11)**	**0 (0)**

Sources: NMFS, 1993; PSEG, Undated

[(a)]The number impinged is shown as the total number impinged, followed by the number of individuals out of the total that were either dead when found in the intake or dead afterward shown in parenthesis. A "-" indicates that no impingements of that species occurred during the given year.

[(b)]Two of the live turtles in 1991 were recaptures.

In 1991, at total of 25 sea turtles were observed, captured or recovered at the Salem circulating water intake. In 1992, during a period of re-initiated Section 7 consultation, PSEG removed the ice barriers attached to the trash racks of the intake, which had previously been left on year-round (PSEG, 2009a). PSEG and NMFS suspected that the ice barriers were attracting sea turtles or in some way reducing sea turtles' ability to easily exit the immediate intake area, and thus, increasing the sea turtles' susceptibility to impingement (PSEG, 2009a). As discussed in Section 2.4.1, in 1993, PSEG began removing the ice barriers between May 1 and October 24 of each year, and in 1999, the

NMFS formalized seasonal ice barrier removal as a requirement of the Biological Opinion (NMFS, 1999). Since 1993, Salem has impinged a dramatically reduced number of sea turtles, which is likely correlated with the seasonal removal of the ice barriers.

5.2 Incidental Takes of Listed Species, 1999-Present

Since the issuance of the 1999 Biological Opinion (NMFS, 1999), Salem has impinged a total of 3 loggerheads (2 of which were dead), and 6 shortnose sturgeon (5 of which were dead) (see Table 6). No green sea turtles, Kemp's ridleys, or leatherbacks were impinged since the issuance of the last Biological Opinion, and no takes of any species occurred in 2009 or in 2010, up to the date of this document's publication.

PSEG does not have record of any Atlantic sturgeon impingements in its intake. However, PSEG does not regularly monitor for Atlantic sturgeon in or near its intake structures because this species is not part of the 1999 Biological Opinion reporting requirements.

Table 6. Reported Incidental Takes of Listed Species at Salem, 1999-Present

Year	Number Impinged[a]					
	Loggerhead Sea Turtle	Green Sea Turtle	Kemp's Ridley Sea Turtle	Leatherback Sea Turtle	Shortnose Sturgeon	Atlantic Sturgeon
1999	-	-	-	-	1 (0)	-
2000	2 (1)	-	-	-	1 (1)	-
2001	1 (1)	-	-	-	-	-
2002	-	-	-	-	-	-
2003	-	-	-	-	1 (1)	-
2004	-	-	-	-	1 (1)	-
2005	-	-	-	-	-	-
2006	-	-	-	-	-	-
2007	-	-	-	-	1 (1)	-
2008	-	-	-	-	1 (1)	-
2009	-	-	-	-	-	-
2010[b]	-	-	-	-	-	-
TOTAL	**3 (2)**	**0 (0)**	**0 (0)**	**0 (0)**	**6 (5)**	**0 (0)**

Sources: PSEG, 2000a; 2001a; 2002; 2003a; 2004a; 2005; 2006a; 2007a; 2008a; 2009c; 2010

[a]The number impinged is shown as the total number impinged, followed by the number of individuals out of the total that were either dead when found in the intake or dead afterward shown in parenthesis. A "-" indicates that no impingements of that species occurred during the given year.

[b]Neither Salem nor HCGS have reported incidental takes from January through November 2010 or in December 2010 up to the date of publication of this document.

5.3 Loggerhead Sea Turtle

Impingement

Loggerhead turtles have been the most abundantly taken species at Salem and HCGS. Since Salem began operation in 1977, PSEG has reported 68 loggerhead individuals (42 live; 26 dead) that have been incidentally taken due to impingement in the Salem circulating water intake (see Tables 5 and 6), which represents 60.2 percent of Salem's total sea turtle takes. HCGS has not reported any impingement of loggerheads or any other species in its intake since it began operating in 1986 (PSEG, 2009b).

As discussed in Section 6.2.1, once PSEG began seasonally removing its ice barriers, PSEG reported an immediate and drastic reduction in sea turtle impingements, specifically of loggerheads, at the circulating water intake. Since 1993, Salem has impinged a total of 6 loggerheads (2 live; 4 dead), and since the issuance of the most recent Biological Opinion (NMFS, 1999), Salem has impinged 3 loggerheads (1 live; 2 dead). The details of the loggerhead incidental takes from 1999-Present are listed in Table 7 below.

Table 7. Loggerhead Incidental Takes, 1999-Present

Date	Condition	Straight Carapace Length in inches (cm)	Straight Carapace Width in inches (cm)	Weight in lbs (kg)	Comments
7/12/00	Dead	24 (60)	22 (55)	n.a.	Severely decomposed; front third of animal missing; clean cut suggestive of boat strike
8/31/00	Live	25 (63)	22 (56.5)	125 (56.7)	Recovered unharmed; tagged and released
8/31/01	Dead	21 (53)	20 (50)	n.a.	Severely decomposed; missing right front flipper and most of right side; assumed dead prior to entering trash racks

n.a. = not available

Sources: PSEG, 2000a; 2001a; 2001b; Undated

Data from the past 11 years of Salem operation (1999-2010) suggest that the impingement loggerhead sea turtle has become relatively rare. No loggerheads have been impinged in the past 9 years of operation. The recorded sizes of the three individuals impinged between 2000 and 2001 indicate that they were juveniles, and two of these were severely decomposed. Because PSEG is required to clean the trash racks three times per week and monitor the trash racks every two hours during turtle season, the two decomposed turtles likely died previous to entering the Salem intake and were then swept into the trash racks due to the increased velocity of water near the intake.

Though loggerhead impingement is of low likelihood, turtles that are in a weakened condition due to fatigue associated with migration; injury from boats; entanglement with or injury from fishing equipment; or disease may not be able to escape the approach velocity (0.9 fps [0.3 m/s]) at the Salem intake and could become impinged. No changes to station operation or maintenance are expected during the period of continued operation or during the proposed 20-year license renewal period. Therefore, the rate of loggerhead impingement experienced at Salem from 1993 through 2010 (after PSEG began to seasonally remove ice barriers) of 1 loggerhead per 3 years can be expected to remain relatively constant with small fluctuations due to variance in the loggerhead population size.

The NRC staff anticipates that Salem is likely to take a small number of loggerheads during its period of continued operation under its current licenses and its proposed 20-year relicensing period. The NRC staff believes that impingement of a small number of loggerheads may affect, but is not likely to adversely affect the loggerhead population in the vicinity of Salem and HCGS.

Entrainment

Because of their life history characteristics, entrainment of loggerhead eggs or hatchlings is not possible. Loggerheads lay eggs on beaches along the southeastern coast of the U.S., and after emerging, hatchlings quickly swim to deep ocean water where they remain until the age of 7 to 12 years (NOAA, 2010e). When juveniles are old enough to migrate to nearshore coastal areas, they are large enough that they would be susceptible to impingement, but not entrainment.

The NRC staff does not anticipate entrainment to adversely affect the loggerhead population in the vicinity of Salem and HCGS.

Heat Shock

The potential impacts of increased water temperatures at the Salem and HCGS discharges on loggerheads are expected to be minimal. Both Salem and HCGS have NJPDES permits which place thermal limits on the maximum discharge temperature and maximum change in ambient estuary temperature cause by facility discharge (see Section 2.3). The high exit velocity of discharge water produces rapid dilution, which limits high temperatures to relatively small areas of the initial mixing zones for both Salem and HCGS. Loggerheads may largely avoid these areas due to high velocities and turbulence. The thermal discharges are not expected to alter foraging behavior because juvenile and adult loggerheads eat mollusks, crabs, shrimp, and other bottom-dwelling fish and invertebrates, while the buoyant thermal plume will rise toward the surface of the estuary. However, if loggerheads do inhabit the discharge area, because the species generally prefers warmer water temperatures and occurs in the Delaware Estuary only during warm months, it is unlikely to be sensitive to the localized area of elevated temperatures at the Salem and HCGS discharges.

Cold-stunning, a condition that occurs when sea turtles remain in localized areas of warm water and then migrate later in the season through waters lower in temperature than they can biologically tolerate (generally lower than 46. 4 °F [8 °C]), can cause sea turtles to become comatose and/or die. NMFS's 1993 Biological Opinion noted that concern surrounding cold-stunning as a result of increased water temperatures at commercial facility discharge points is not supported by existing data. Additionally, the Delaware Estuary does not drop to temperatures as low as 46.4 °F (8 °C) until late November or early December (NODC, 2010), and no turtles of any species have been observed at Salem or HCGS this late in the year. PSEG (Undated)'s impingement data indicates that the majority of loggerheads leave the area by late September. The majority of impingements (47.1 percent) have occurred in July, and the latest in the year that PSEG has reported a loggerhead impingement is September 30 (in 1985) (PSEG, Undated).

The NRC staff does not expect heat shock to adversely affect the loggerhead population in the vicinity of Salem and HCGS.

or injury from fishing equipment; or disease may not be able to escape the approach velocity (0.9 fps [0.3 m/s]) at the Salem intake and could become impinged. The NRC staff concludes that Salem could, but is not likely to, incidentally take a very small number of Kemp's ridleys during its period of remaining operation under its current licenses and during its proposed 20-year relicensing period. The NRC staff believes that impingement of a very small number of Kemp's ridleys is not likely to adversely affect the Kemp's ridley sea turtle population in the vicinity of Salem and HCGS.

Entrainment

Because of their life history characteristics, entrainment of Kemp's ridley eggs or hatchlings is not possible. Kemp's ridleys's nesting behavior is restricted to primarily one beach area—Rancho Nuevo, Tamaulipas, Mexico—and occasionally the species uses two additional nesting grounds in Padre Island, Texas, and Veracruz, Mexico. Once juveniles begin to migrate north up the coast, they are large enough that they would be susceptible to impingement, but not entrainment.

The NRC staff does not expect entrainment to adversely affect the Kemp's ridley sea turtle population in the vicinity of Salem and HCGS.

Heat Shock

The impacts of heat shock on the Kemp's ridley are the same as those described for the loggerhead in Section 5.3. The NRC staff does not expect heat shock to adversely affect the Kemp's ridley population in the vicinity of Salem and HCGS.

5.6 Leatherback Sea Turtle

Impingement

The leatherback sea turtle is known to occur in the vicinity of the Delaware Estuary in the summer months, but the species has never been impinged at Salem or HCGS and was not included in the any of the previous Biological Opinions for Salem and HCGS. Due to the leatherback adults' large size (up to 2,000 lbs [900 kg] and 55 in. [140 cm]) (NOAA, 2010d), adult individuals would be able to escape the Salem circulating water intake despite the intake water velocity. Hatchlings and juvenile leatherbacks smaller than 39 in. (100 cm) are not expected to be in the vicinity of Salem and HCGS because Eckert (2002) noted that leatherbacks smaller than 39 in. (100 cm) are only sighted in waters warmer than 79 °F (26 °C). According to the National Oceanographic Data Center's Coastal Water Temperature Guide for the Central Atlantic Coast (NODC, 2010), the Delaware Estuary's average water temperatures do not reach as high as 79 °F (26 °C), even in August. Therefore, the NRC staff does not anticipate the leatherbacks of any life stage to be impinged at Salem or HCGS during the remaining period of operation or during the proposed 20-year period of license renewal.

Entrainment

Because of their life history characteristics, entrainment of leatherback eggs or hatchlings is not possible. Leatherbacks lay eggs on beaches far south of Salem and HCGS—in the U.S. Caribbean, the U.S. Virgin Islands, and southeast Florida, and other tropical beaches around the globe. After emerging, hatchlings quickly swim to deep ocean water where they remain until they reach the juvenile stage. When juveniles are old enough to migrate to nearshore coastal areas, they are large enough that they would be susceptible to impingement, but not entrainment.

The NRC staff does not expect entrainment to adversely affect the leatherback sea turtle population in the vicinity of Salem and HCGS.

Heat Shock

The impacts of heat shock on the leatherback are the same as those described for the loggerhead in Section 5.3. The NRC staff does not expect heat shock to adversely affect the leatherback turtle population in the vicinity of Salem and HCGS.

5.7 Shortnose Sturgeon

Impingement

Since PSEG began seasonally removing Salem's ice barriers in 1993, the sea turtle impingement rate has decreased drastically, and the shortnose sturgeon has become the most abundantly taken protected species at Salem. Shortnose sturgeon account for 61 percent of listed species impingements from the period 1993 through 2010. Since Salem began operation in 1977, PSEG has reported 19 shortnose sturgeons (3 live; 16 dead) that have been incidentally taken due to impingement in the Salem circulating water intake (see Tables 5 and 6). HCGS has not reported any impingement of shortnose sturgeon or any other species in its intake since it began operating in 1986 (PSEG, 2009b).

Table 8. Shortnose Sturgeon Incidental Takes, 1999-Present

Date	Condition	Fork Length in inches (cm)	Total Length in inches (cm)	Weight in lbs (kg)	Comments
3/31/99	Live	23 (59)	25 (63)	2.2 (1)	n.a.
4/18/00	Dead	30 (76)	33 (85)	4.6 (2.1)	Wound behind right gill and two gashes on top and right side of body
4/09/03	Dead	~27 (~69)	n.a.	~5.5 (~2.5)	Live when caught; tail mostly severed; died shortly after recovery
10/01/04	Dead	25.4 (64.6)	29.0 (73.7)	2.4 (1.1)	Died shortly after recovery; appeared weak and underweight for its size
11/28/07	Dead	n.a.	26.5 (67.4)	5 (11)	Mostly decomposed
7/31/08	Dead	n.a.	20 (50.8)	2.0 (0.9)	Severely decomposed

n.a. = not available

Sources: PSEG, 2000a; 2000b; 2003a; 2003b; 2004a; 2004b; 2007a; 2007b; 2008a; 2008b; Undated

Data from 1977 through 2010 indicate that the 1993 PSEG ice barrier procedure change did not impact the likelihood of shortnose sturgeon to be impinged. Pre-1993, Salem impinged shortnose at a rate of 0.50 individuals per year, and post-1993, Salem has impinged shortnose at a rate of 0.65 individuals per year. The variance in impingement rates over the two time periods may be attributable to fluctuations in the shortnose population in the vicinity of Salem.

Of the shortnose that have been impinged since the issuance of the current Biological Opinion (NMFS, 1999), the recorded sizes of the six individuals impinged (see Table 8) indicate that they were juveniles and that the majority were either dead upon recovery or died soon after recovery. In three of the five cases of lethal shortnose takes between 1999 and 2010, individuals had fresh wounds that were likely directly attributable to plant operation. Healthy adult and juvenile shortnose sturgeon would be strong enough swimmers to escape the increased water velocity at the intake; therefore, the NRC staff expects Salem to impinge weakened, injured, diseased, or deceased shortnose with higher frequency.

No changes to station operation or maintenance are expected during the period of continued operation or during the proposed 20-year license renewal period. Therefore, the rate of approximately one shortnose sturgeon impingement per two years that Salem has experienced from 1978 through 2010 can be expected to remain relatively constant with small fluctuations due to variance in the shortnose sturgeon population size.

Based on the historic rate of shortnose impingement, the NRC staff anticipates that Salem is likely to take up to 15 to 20 shortnose sturgeon during the proposed 20-year license renewal term, which would extend the operating period of Salem through August 13, 2036, and April 18, 2040, for Salem, Units 1 and 2, respectively. The NRC staff believes that impingement of this number of shortnose sturgeon may affect, but is not likely to adversely affect, the shortnose sturgeon population in the vicinity of Salem and HCGS.

Entrainment

The life history of the shortnose sturgeon suggests that entrainment of its eggs or larvae is unlikely. Within the Delaware Estuary-River complex, shortnose sturgeon spawn north of Trenton (about 79.5 river miles [128 river kilometers] upstream from Salem) in fresh reaches of the Delaware River. Eggs adhere to river substrate, and juvenile stages tend to remain in freshwater or fresher areas of the estuary for 3 to 5 years before moving downriver to more saline reaches of the estuary or ocean. Thus, shortnose sturgeon eggs or larvae are unlikely to be present in the water column at the Salem or HCGS intakes, and entrainment of the species' eggs or larvae is unlikely.

Additionally, in the SEIS for Salem and HCGS (NRC, 2010) the NRC staff evaluated the potential effects of entrainment, impingement, and thermal discharges on aquatic species in Sections 4.5.2, 4.5.3, and 4.5.4. Based on an examination of PSEG's entrainment data, the NRC (2010a) noted that PSEG has not collected the eggs or larvae of shortnose sturgeon in annual entrainment monitoring samples from 1978 to 2008, and the NRC staff concluded that no evidence existed that would suggest that the eggs or larvae of shortnose sturgeon might be entrained at Salem or HCGS.

Heat Shock

The potential impacts of increased water temperatures at the Salem and HCGS discharges on shortnose sturgeon are expected to be minimal. Both Salem and HCGS have NJPDES permits which place thermal limits on the maximum discharge temperature and maximum change in ambient estuary temperature cause by facility discharge (see Section 2.3). The high exit velocity of discharge water produces rapid dilution, which limits high temperatures to relatively small areas of the initial mixing zones for both Salem and HCGS. Shortnose sturgeon may largely avoid these areas due to high velocities and turbulence. Shortnose sturgeon spawning and nursery areas do not occur in the area of the discharge in the estuary. Juvenile and adult sturgeon forage on the river bottom, while the buoyant thermal plume will rise toward the surface of the estuary. Therefore, the NRC does not expect the thermal discharge to adversely affect any life stage of the shortnose sturgeon.

5.8 Atlantic Sturgeon

Impingement

Because the Atlantic sturgeon was not proposed for listing under the ESA until January 2010 (75 FR 838), it is not included in Salem and HCGS's 1999 Biological Opinion. Bottom trawl data indicate that the Atlantic sturgeon is present in the vicinity of Salem and HCGS (PSEG, Undated). PSEG has not recorded any Atlantic sturgeon impingements at Salem or HCGS. However, PSEG does not specifically monitor for Atlantic sturgeon. Because HCGS has not impinged any listed species since it began operation, the NRC staff assumes that HCGS would also not impinge any Atlantic sturgeon.

Atlantic sturgeon are similar in life history and appearance to the shortnose sturgeon, but Atlantic sturgeon grow to be up to three times the size in length and significantly heavier than shortnose sturgeon, which suggests that Atlantic sturgeon would be more capable of escaping the increased water velocity at the intake. The size of the Delaware River population of Atlantic sturgeon is largely unknown; however, the Atlantic Sturgeon Status Review Team (2007) noted that population estimates based on mark and recapture of juveniles indicated that between 1991 and 1995, the Delaware River Atlantic sturgeon population fluctuated between an estimated 1,000 and 5,600 individuals. By contrast, Hastings et al. (1987) and the Shortnose Sturgeon Recovery Team (1998) reported that the shortnose sturgeon population within the Delaware River was between 6,408 and 14,080 individuals. Though these numbers only provide a crude comparison, this data indicates that the Atlantic sturgeon population is the smaller of the two sturgeon populations within the Delaware Estuary-River complex, and would, therefore, be statistically less likely to be impinged at Salem.

Given the larger size of the Atlantic sturgeon and smaller population size in comparison to the shortnose sturgeon, the NRC staff anticipate that Atlantic sturgeon are less likely to be impinged in Salem's intake than the shortnose sturgeon. The NRC staff concludes that Salem could, but is not likely to, incidentally take a very small number of Atlantic sturgeon during its period of remaining operation under its current licenses and during its proposed 20-year relicensing period. The NRC staff believes that impingement of a very small number of Atlantic sturgeon is not likely to adversely affect the species' population in the vicinity of Salem and HCGS.

Entrainment

The life history of the Atlantic sturgeon suggests that entrainment of its eggs or larvae is unlikely. Within the Delaware Estuary-River complex, Atlantic sturgeon spawn upriver of Salem and HCGS in fresh reaches of the Delaware River. Eggs adhere to river substrate, and juvenile stages remain in freshwater or fresher areas of the estuary for a number of months before migrating downstream to more saline reaches of the estuary or ocean. Because larvae actively migrate in deep waters, the Atlantic Sturgeon Status Review Team (2007) noted that the species' migratory behavior means that larvae avoid intake structures of water-withdrawing facilities. Thus, Atlantic sturgeon eggs or larvae are unlikely to be present in the water column at the Salem or HCGS intakes, and entrainment of the species' eggs or larvae is unlikely.

Additionally, as described in Section 5.7, the NRC staff evaluated the potential effects of entrainment, impingement, and thermal discharges on aquatic species in the SEIS for Salem and HCGS (NRC, 2010). Based on PSEG's annual entrainment monitoring samples from 1978 to 2008, the NRC staff concluded that no evidence existed that would suggest that the eggs or larvae of Atlantic sturgeon might be entrained at Salem or HCGS.

Heat Shock

The impacts of heat shock on the Atlantic sturgeon are the same as those described for the shortnose sturgeon in Section 5.7. The NRC staff does not expect heat shock to adversely affect any life stage of the Atlantic sturgeon.

6.0 Cumulative Effects Analysis

The four sea turtle species discussed in this Biological Assessment are affected by the same human-induced and natural threats but to varying degrees based on differences in each species' range, migratory patterns, and behaviors. Table 9 provides a summary of the major threat categories for the loggerhead, green, Kemp's ridley, and leatherback sea turtles and the extent to which each category affects each species expressed as "low," "moderate," or "high." The following sections discuss the cumulative effects of threats to each species individually.

Table 9. Summary of Threats to Sea Turtle Species

Threat[a]	Description of Threat	Species			
		Loggerhead	Green	Kemp's Ridley	Leatherback
Direct Impacts					
Fisheries Bycatch	Includes bottom trawl; top/mid-water trawl; dredge; longline; gillnet; pot/trap; haul seine; purse seine; and commercial hook and line.	**HIGH.** Longline, bottom and mid-water trawls pose the largest threats.	**MODERATE.** Given the green sea turtles' use of both nearshore and deep ocean habitat, it is susceptible to all types of fisheries.	**HIGH.** Bottom trawl, specifically within the shrimp industry, poses the largest threat.	**HIGH.** Longline and bottom trawl pose the largest threat.
Non-fishery Resource Use	Includes illegal harvest; illegal harvest for research and other purposes; industrial plant impingement/ entrainment; and boat strikes.	**LOW**	**HIGH.** The species is not afforded official protection in all countries, and harvest of all life stages is a major problem worldwide.	**MODERATE.** Boat strikes affect a high percentage of Kemp's ridley due to their preference for nearshore habitat.	**HIGH.** Many leatherbacks nest in countries that do not have regulations prohibiting harvest of the species.
Indirect Impacts					
Construction	Includes beach nourishment; beach armoring; shoreline stabilization; dredging; and oil, gas, and natural gas exploration, development, and removal	**LOW**	**MODERATE.** Green sea turtles use beaches worldwide in countries that may not have stringent restrictions on shoreline development.	**LOW**	**HIGH.** Many leatherbacks nest in countries that do not have specific habitat protection.

Threat[a]	Description of Threat	Species			
		Loggerhead	Green	Kemp's Ridley	Leatherback
Ecosystem Alteration	Includes trophic changes from fishing; trophic changes from benthic habitat alteration; beach erosion; dams; runoff and hypoxia; vegetation alteration in coastal areas; and sand mining.	LOW	LOW	LOW	LOW
Pollution	Includes marine debris ingestion and/or entanglement; beach debris obstruction; oil, fuel, tar, and chemicals; light pollution; noise pollution; and other toxins.	**HIGH.** Juveniles are especially susceptible to marine debris ingestion and entanglement .	**HIGH.** Juveniles are especially susceptible to marine debris ingestion and entanglement.	LOW	LOW
Species Interactions	Includes predation; pathogens and disease; domestic animals; exotic species; and toxic species.	LOW	**MODERATE.** Fibropapillomatosis is becoming more prevalent in stranded green sea turtles.	**MODERATE.** A high natural predator load in Rancho Nuevo increases the likelihood of unprotected nests to be destroyed.	LOW
Other Factors	Includes climate change; natural catastrophe; conservation/ research activities; military activities; and cold stunning.	**MODERATE.** Climate change may affect available nesting habitat and alter the sex ratio.	**MODERATE.** Climate change may affect available nesting habitat and alter the species' range.	LOW	LOW

[a]For a more detailed description of each threat, refer to "Table A1-1. Threat Categories and Description" in NMFS and FWS, 2010

This table is based on data from the following sources: Conant et al., 2009a; 2009b; NMFS and FWS, 2007a; 2007b; 2007c; 2007d; 2008; 2010; Seminoff, 2004; Turtle Expert Working Group, 2007

Though the shortnose and Atlantic sturgeons have similar life histories, and therefore, face similar threats, the species are discussed in Sections 6.5 and 6.6 separately due to the fact that Atlantic sturgeon is not formally protected under the ESA and has been extensively harvested in more recent years.

6.1 Loggerhead Sea Turtle

During the most recent NMFS status review of the loggerhead, Conant et al. (2009a) created a stage-based deterministic model to predict each proposed loggerhead DPS's extinction risk. Conant et al. (2009a) concluded that even with maximum population growth and a lowered threat of human-related mortality, the Northwest Atlantic DPS will likely decline in the forseeable future.

Longline fishing and entanglement in marine debris pose the greatest threat to juvenile and adult loggerheads. Conant et al. (2009b) characterized these as "medium-high" threats with an increasing trend. Other types of fisheries—bottom and mid-water trawl, dredge, gillnet, pot/trap—in the Gulf of Mexico and along the Atlantic coast pose a "medium" level threat to juveniles and adults, specifically those migrating or foraging nearer to the shore. Conant et al. (2009b) also considered boat strikes to be a "medium" and growing threat, with the number of reported boat strikes or injured sea turtle strandings increasing yearly.

Though habitat modification and destruction has been a major threat to the loggerhead—especially to nesting females, eggs, and hatchlings—in the past, since the listing of the species under the ESA, this threat has drastically decreased. Conant et al. (2009b) noted that only a few nesting females are documented as being killed as a result of habitat modification, and that even though a number of factors (including beach/shore modifications/stabilization, coastal construction, human presence, lighting, and fencing) threaten eggs and hatchings, the overall threat level is believed to be relatively low.

Illegal harvest of eggs continues to occur, though at very low numbers. The estimated annual illegal egg harvest ranges from 1,001 to 10,000 eggs, based on combined estimates from Florida, Georgia, South Carolina, and North Carolina (Conant et al., 2009b). Disease and predation-related mortalities are also believed to be low (Conant et al., 2009).

Sea level rise and increasing ocean temperatures associated with climate change has the potential to threaten the loggerhead's nesting sites and loggerhead sex ratios. Increased beach erosion due to sea level rise, increase in storm frequency, and changes in prevailing currents could reduce available nesting habitat (NMFS and FWS, 2008). Increases in ambient ocean temperature may impact the loggerhead populations' sex ratio because loggerheads exhibit a temperature-dependent sex distribution, with more females resulting from eggs incubated at higher temperatures (NMFS and FWS, 2008).

Though the impingement of loggerheads in commercial facility intake systems has been documented along the U.S. Atlantic coast from New Jersey to Florida and along the Gulf of Mexico in Texas, the NMFS and FWS (2008) reported that the average capture rates from coastal commercial plants is very low.

Overall, longline fishing and entanglement in marine debris pose the greatest threat to the Northwest Atlantic loggerhead population, and when considered with other threats such as other types of fisheries, boat strikes, habitat modification/destruction, illegal egg harvest, climate change, and power facility impingement, the cumulative impacts to the loggerhead are likely to result in a significant and large cumulative effect. The NMFS and FWS (2008) reported a declining population trend in all five recovery units within the Northwest Atlantic loggerhead population, and Conant et al. (2009a) concluded that the population is likely to continue to decline under all potential population growth and human threat level scenarios.

6.2 Green Sea Turtle

Due to the green sea turtle's similar life history to the loggerhead, cumulative impacts to the green sea turtle are similar to those discussed in Section 6.1 for the loggerhead. However, because the applicability of the DPS policy has not been assessed for the green turtle, to conservatively estimate the cumulative impacts to the green turtle population, the NRC staff has included threats posed globally and not just those in the U.S. and neighboring countries.

In their five-year review of the green sea turtle, the NMFS and FWS (2007a) noted that illegal harvest of eggs, injuring or killing of nesting females on beaches, direct hunting of adults in foraging areas, and fishery bycatch pose the highest threat level to the green sea turtle. Egg harvesting is minimal within the U.S., but continues to be a major threat worldwide in Comoras Island, Costa Rica, Gambia, Equatorial Guinea, Guinea-Bissau, India, Indonesia, Ivory Coast, Malaysia, Maldives, Mexico, Panama, Philippines, Sao Tome é Principe, Saudi Arabia Senegal, Sri Lanka, Thailand, and Vietnam (Seminoff, 2004).

The loss of nesting females reduces both the adult population and the population's potential annual egg production. Because females do not mature until 20 to 50 years of age (NOAA, 2010b), nesting female mortality is a substantial loss due to the replacement time and the lost egg production during this lapse. Australia, Bioko Island, Costa Rica, Guinea-Bissau, India, Japan, Mexico, Seychelles, and Yemen are all known to have issues with harvesting of nesting females (Seminoff, 2004).

Foraging juveniles and adults are often harvested within nearshore foraging habitat, which when considered with the loss of nesting females, may cause a crash in the adult nesting population in coming decades. Poachers along the coast of Nicaragua killed approximately 11,000 green sea turtles per year in the 1990s (NMFS and FWS, 2007a). In Southeast Asia, up to 100,000 green sea turtles were harvested annually as recent at the late 1990s, and in the eastern Pacific, up to 10,000 green sea turtles were harvested per year (NMFS and FWS, 2007a). Seminoff (2004) cited 34 specific countries off the coast of which green sea turtle harvesting is known to occur and poses a threat to the species.

Fishery bycatch, especially in nearshore fisheries, is likely to significantly affect the green sea turtle, though specific estimates on the number of fishery bycatch-related green sea turtles mortalities is not available.

Fibropapillomatosis, a disease that causes external tumors that can interfere with swimming, vision, feeding, and escape from predators if they tumors grow too large (FFWCC, 2010), is most prevalent in green sea turtles and may also cumulatively contribute to the decline of the species. From 1980 to 2005, the Florida Sea Turtle Stranding and Salvage Network reported that 22.2 percent of stranded green turtles in Florida had fibropapillomatosis tumors (FFWCC, 2010). Statistics for infection rates of green sea turtles found migrating as far north as New Jersey are unavailable.

Overall, illegal harvest of eggs, injuring or killing of nesting females on beaches, direct hunting of adults in foraging areas, fishery bycatch, and other human-related causes of sea turtle mortality such as those discussed in Section 6.1 are likely to cumulatively result in a significant and moderate cumulative effect. The NMFS and FWS (2007a) concluded that of 23 nesting concentrations, 9 were believed to be stable and 4 were believed to be decreasing. The NMFS and FWS (2007a) noted that populations in the Pacific, Western Atlantic, and Central Atlantic Ocean were increasing, while populations in Southeast Asia, the Eastern Indian Ocean, and the Mediterranean were likely decreasing.

6.3 Kemp's Ridley Sea Turtle

In March 2010, the NMFS and FWS (2010) published a draft Revised Recovery Plan for the Kemp's ridley sea turtle that identified all significant sources of Kemp's ridley mortality and included an in-depth threat analysis by life stage and ecosystem. The NMFS and FWS (2010) identified the highest human-related threats to the species as fishery bycatch and boat strikes.

Unlike other sea turtle species that are most sensitive to longline fisheries, the overwhelming majority of Kemp's ridley mortalities are estimated to be as a result of bottom trawling for shrimp off the U.S. Atlantic coast and Gulf of Mexico due to the fact that the Kemp's ridley rarely travels long distances offshore. The NMFS and FWS (2010) estimated shrimp trawl-related mortalities to be 10 times greater than that of all other human-related threats combined. In the U.S. and Gulf of Mexico, the estimated annual mortality is up to 4,208 individuals based on data through 2001, though the NMFS and FWS (2010) suggested that the reduced shrimping effort in recent years would be expected to directly reduce annual Kemp's ridley mortalities. In 1987, NMFS adopted a standardized guideline on Turtle Excluder Devices (TEDs)—devices capable of separating the target catch from the bycatch—to require approved TEDs to be 97 percent effective in excluding turtles. Though TEDs have the potential to drastically reduce Kemp's ridley bycatch, TEDs are not required of all fisheries or in all U.S. states.

In addition to bottom trawl, the NMFS and FWS (2010) identified other types of fisheries, including mid-water trawl, gillnet, commercial hook and line, longline, and others, to cumulatively account for approximately 4,960 Kemp's ridley deaths per year (NMFS and FWS, 2010).

Kemp's ridleys are likely more susceptible to boat strikes than other sea turtle species because Kemp's ridleys spend the majority of their lives in the nearshore zone. The NMFS and FWS (2010)'s threat analysis indicated that between 101 and 1,000 Kemp's ridley mortalities per year can be attributed to boat strikes. Additionally, many live Kemp's ridleys would be expected to sustain wounds but not die from boat strikes. From 1997 to 2001, the Sea Turtle Stranding and Salvage Network reported that 12.7 percent of stranded turtles have injuries attributable to boat strikes (NMFS and FWS, 2010).

Prior to 1966, the major threat to the Kemp's ridley's continued existence was egg collection on nesting beaches, but because the species nests in one main location, the Mexican Government afforded the Rancho Nuevo beach official protection in 1966 (NMFS, 1994). Because nesting habitat is protected, the Kemp's ridley's strict loyalty to a small number of nesting sites and its reduced range in comparison to other sea turtle species minimizes the likelihood of illegal harvest of any life stage. The NMFS and FWS (2010) do not consider illegal harvest to be a major threat to the species.

Overall, fishery bycatch—specifically bottom trawl, boat strikes, and the cumulative effect of other human-related Kemp's ridley mortality are likely to result in a significant and moderate cumulative effect to the Kemp's ridley population when considered with the discussion of predicted Kemp's ridley population growth in Section 4.3.

6.4 Leatherback Sea Turtle

The North Atlantic leatherback population is considered stable according to the Turtle Expert Working Group (2007); however the species is threatened by a number of human-induced threats, the greatest of which are fishery bycatch, marine debris, poaching, and boat strikes. Though the species has not been assessed for applicability of the DPS policy, to conservatively estimate the cumulative impacts to the green turtle population, the NRC staff has included threats posed globally and not just those in the U.S. and neighboring countries.

Because leatherbacks nest worldwide, nesting habitat is becoming increasingly impacted through a variety of threats including natural disasters (such as the 2004 Indian Ocean tsunami and shifting mudflats in the Guianas), beach development, and beach stabilization or other alterations (NMFS and FWS, 2007c). The majority of countries that the leatherback nests in do not have regulations in place to protect the species' nesting habitat.

Egg collection is also an issue in many countries due to the absence of regulations protecting the leatherback. This combined with leatherback's natural low hatching success could result in a significant impact to the species' population in countries where egg collection is not prohibited.

Longline fisheries and bottom-trawl fisheries account for the largest documented takes of leatherbacks in U.S. waters—possibly as many as 3,090 takes per year, of which 80 result in death (Expert Turtle Working Group, 2007). Ingestion or entanglement in marine debris, however, is not thought to be a source of concern for the leatherback (Turtle Expert Working Group, 2007), possibly due to its large size.

Because the leatherback is the most widely distributed sea turtle species, it may not be noticeably affected by environmental changes attributable to climate change. Some concern exists over increasing temperatures altering the species' sex ratios; however, some leatherback females are known to prefer depositing eggs in cooler tide zones, which may mitigate the effects of rising temperatures (NMFS and FWS, 2007c).

Overall, habitat destruction/modification, egg collection, and fishery bycatch are likely to result in a significant and moderate cumulative effect on the leatherback population when considered together.

6.5 Shortnose Sturgeon

In their recovery plan for the shortnose sturgeon, the NMFS (1998) reported that the U.S. shortnose sturgeon population is most significantly affected by commercial facility intakes, water contaminants, fishery bycatch, bridge construction and demolition, dams, and dredging.

The NMFS (1998) reported that commercial facility intakes have the greatest likelihood of directly affecting the sturgeon populations, especially those located upriver, because of the likelihood to entrain vulnerable life stages.

Toxic metals, pesticides, PCBs, and other contaminants can cause lowered larval survival rates, growth retardation, and reproductive failure in fish species. Though specific cause-effect correlations are not known for the shortnose, certain toxins, such as PCBs, are known to accumulate in the tissues of shortnose (NMFS, 1998).

Shortnose sturgeon bycatch is common along the U.S. Atlantic coast. One report estimated that in shad fisheries within northeast U.S. rivers, individual fisheries may take up to 20 shortnose per year (NMFS, 1998). Most shortnose are returned to the river unharmed; therefore, bycatch does not ultimately appear to be significantly affecting the shortnose sturgeon's population.

Activities that interfere with the shortnose sturgeon's migratory patterns and distribution include bridge construction and demolition and dams. No specific data exists regarding the number of individual mortalities or severity of impact, but the NMFS (1998) suggested that build up of sediments downstream of projects and shock from use of explosives could adversely impact shortnose sturgeon. Hydroelectric dams restrict habitat, alter river flow, and may change river temperature, which can alter or prohibit migration patterns. Kynard (1997) noted that in all but one northeast U.S. river, the first dam on the river is also the upper limit of the shortnose sturgeon's population range, indicating that dams have reduced the shortnose sturgeon's historic range and may ultimately restrict population growth. Sturgeon appear unable to use fish ladders, but are able to navigate dams that have fish lifts (NMFS, 1998). Though dams affect the shortnose sturgeon as a whole, the Delaware River does not have any dams, and therefore, the Delaware River population is not threatened by damming.

Dredging can directly cause shortnose sturgeon mortality and can indirectly affect the shortnose through changes to the environment such as destruction of benthic feeding areas, disrupting spawning migrations, and filling in spawning habitat. The NMFS (1998) noted that imposing seasonal work restrictions to alternative dredge methods can greatly reduce the likelihood of impacts to shortnose sturgeon.

Given that the Delaware River population of shortnose sturgeon is thought to be one of the healthiest shortnose populations (Hastings et al., 1987), the cumulative impacts of commercial facility intakes, water contaminants, fishery bycatch, bridge construction and demolition, dams, and dredging are likely to result in a significant and small cumulative effect on the shortnose population when considered together.

6.6 Atlantic Sturgeon

Atlantic sturgeon face the same threats as those described for the shortnose sturgeon in Section 6.5. The Atlantic sturgeon has been commercially fished more heavily and for a longer period of time than the shortnose sturgeon. While shortnose were primarily only taken as bycatch, a thriving Atlantic sturgeon fishery has existed since the mid-1800s.Harvests ranged from 7.4 million lbs (3350 mt) in 1890 to 108,000 lbs (49 mt) by the early 1990s (ASSRT, 2007). The Atlantic States Marine Fisheries' 1990 Fisheries Management Plan for the Atlantic sturgeon suggested that historic landings indicated rapid over exploitation before the stock collapsed because a majority of females were being harvested before being able to spawn (ASSRT, 2007). In 1998, the Atlantic States Marine Fisheries Commission instituted a moratorium on Atlantic sturgeon harvest in U.S. waters.

Despite the fishery moratorium, the Atlantic sturgeon is still caught as bycatch. Based on data from 2001 to 2006, the ASMFC (2007) estimated that between 2,752 and 7,904 individuals per year are caught as bycatch in sink gillnets, and 2,167 to 7,210 individuals per year are caught as bycatch in trawls. Poaching may also pose a significant threat, though the magnitude of poaching activity is unknown (ASSRT, 2007).

Today, within the Delaware Estuary and proposed New York Bight DPS, the Atlantic sturgeon population's continued existence is threatened primarily by dredging, vessel strikes, reduced water quality, and fishery bycatch (75 FR 61872). Range-wide, habitat degradation, dams, water withdrawals, and declining water quality due to coastline development are among the most common threats to the species (NOAA, 2010a). Given threats discussed in Section 6.5, which also affect the Atlantic sturgeon, the historical effects of the fishery collapse, and the fact that the species is now a candidate for listing under the ESA, the cumulative impacts of these threats are likely to result in a significant and large cumulative effect on the Atlantic sturgeon population when considered together.

7.0 Conclusion and Determination of Effects

Because HCGS has never impinged a listed species during its 24 years of operation and no additional data exist that indicates that HCGS would have an adverse effect on any listed species in the future, the NRC staff concludes that HCGS will have **no effect** on any listed species.

Conclusions regarding Salem's affect on listed species are addressed below by species. All Salem conclusions are made for the combined period of continued operation under Salem's current operating license (6 and 10 years for Units 1 and 2, respectively) and the proposed 20-year relicensing period.

7.1 Loggerhead Sea Turtle

The NRC staff concludes that Salem **may affect, but is not likely to adversely affect** the loggerhead sea turtle. The NRC staff concludes that Salem is likely to impinge a small number of loggerhead juveniles and adults over the course of the combined period of continued operation and proposed 20-year relicensing period. The NRC staff believes that the rate of loggerhead impingement will be similar to the rate of impingement recorded from 1993 through 2010—one loggerhead per three years—and may vary by year based on the loggerhead population size, weather events, and other environmental factors.

7.2 Green Sea Turtle

The NRC staff concludes that Salem **may affect, but is not likely to adversely affect** the green sea turtle. The NRC staff concludes that Salem is likely to impinge a small number of green sea turtle juveniles and adults over the course of the combined period of continued operation and proposed 20-year relicensing period. Based on data from 1993 through 2010, the NRC staff believes that the rate of green sea turtle impingement will be lower than the rate of loggerhead impingement and may vary by year based on the green sea turtle's population size, weather events, and other environmental factors.

7.3 Kemp's Ridley Sea Turtle

The NRC staff concludes that Salem **may affect, but is not likely to adversely affect** the Kemp's ridley turtle. The NRC staff concludes that there is a small likelihood that Salem will impinge one to a few Kemp's ridley sea turtles over the course of the combined period of continued operation and proposed 20-year relicensing period. Salem has not impinged any Kemp's ridleys from 1994 through 2010, which the NRC staff believes to be attributable to PSEG's change in procedures to seasonally remove the ice barriers at the intake beginning in 1993. However, the NRC staff believes that it is possible that Salem may impinge a Kemp's ridley in the future because the species is known to occur in the vicinity of Salem and because the species has historically been impinged at Salem.

7.4 Leatherback Sea Turtle

The NRC staff concludes that Salem will have **no effect** on the leatherback sea turtle. The NRC staff concludes that no leatherback life stage is likely to be impinged at Salem over the course of the combined period of continued operation and proposed 20-year relicensing period due to the species' life history characteristics, large size, and small juveniles' preference for waters warmer than those found in the Delaware Estuary.

7.5 Shortnose Sturgeon

The NRC staff concludes that Salem **may affect, but is not likely to adversely affect** the shortnose sturgeon. The NRC staff concludes that Salem is likely to impinge some shortnose juveniles and adults over the course of the combined period of continued operation and proposed 20-year relicensing period. The NRC staff believes that the rate of shortnose impingement will be similar to the rate of impingement recorded from 1978 through 2010—about one shortnose sturgeon per two years—and may vary by year based on the shortnose sturgeon population size, weather events, and other environmental factors.

7.6 Atlantic Sturgeon

The NRC staff concludes that Salem **may affect, but is not likely to adversely affect** the Atlantic sturgeon. The NRC staff concludes that Salem is likely to impinge a small number of Atlantic sturgeon juveniles and adults over the course of the combined period of continued operation and proposed 20-year relicensing period. The NRC staff believes that the rate of Atlantic sturgeon impingement will be lower than the rate of shortnose sturgeon impingement based on the larger size and smaller population of Atlantic sturgeon, and the impingement rate may vary by year based on the species' population size, weather events, and other environmental factors.

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We are requesting your concurrence with our determination. In reaching our conclusion, the NRC staff relied on information provided by the applicant, on research performed by NRC staff, and on information from NMFS (including current listings of species provided by the NMFS). If you have any questions regarding this BA or the staff's request, please contact Ms. Leslie Perkins, Environmental Project Manager, at 301-415-2375 or by e-mail at leslie.perkins@nrc.gov.

Sincerely,
/RA/
Bo M. Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-272, 50-311, and 50-354

Enclosure:
As stated

cc w/encl.: Distribution via Listserv

ADAMS Accession No.: ML103350271

OFFICE	LA:DLR	PM:DLR:RPB1	BC:DLR:RPB1
NAME	IKing	LPerkins	BPham
DATE	12/9/10	12/13/10	12/13/10

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Letter to Mary A. Colligan from Bo M. Pham dated December13, 2010.

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